FINAL REPORT

Human Health Risk Assessment, Occupation of Lot 100, 42 Walker Street, Rhodes

Prepared for

Australian Remediation Services Pty Ltd

Level 11, Meriton Tower
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URS Australia Pty Ltd (URS) were commissioned by Australian Remediation Services Pty Ltd (Meriton) to undertake a Human Health Risk Assessment for the future residents residing on Lot 100, 42 Walker Street Rhodes (located at the former Allied Feeds Site), (the site).

The assessment was undertaken with consideration of the potential impacts to human health to residents at Lot 100 from construction of remaining apartments and decommissioning of the remediation system and equipment on the Allied Feeds site and the ongoing remediation of the Lednez site (to the south of the site). The remediation of both the Allied Feeds site and Lednez site is managed by Thiess Services Pty Ltd (Thiess).

The assessment has been undertaken utilising the available information provided to URS as listed in **Section 2.2** of this report. Identified data gaps listed in **Section 2.7** should be read with respect to the conclusions presented.

The scope of work included consideration of the following:

- Calculation of ambient air concentrations for a range of substances from operational emission sources on the Lednez site and construction activities on the Allied Feeds site using both dispersion modelling and ambient monitoring data;
- Qualitative Noise assessment; and
- Qualitative Odour assessment.

ES 1.1 Approach to Assessment

The approach to the prediction of ambient air concentrations at Lot 100 involved the development of an air emissions inventory, compilation of meteorological and terrain data, dispersion modelling using CALPUFF and the incorporation of site ambient monitoring data.

A qualitative noise and odour assessment was undertaken where the available investigations were reviewed and conclusions were drawn about the potential exposures for residents on Lot 100.

Ground level concentrations of a range of air pollutants were predicted using dispersion modelling, and site ambient monitoring data. The list of species assessed included products of combustion, particulate matter, volatile and semi volatile organic compounds, metals and other air toxics. The combined stack and ground source concentrations for individual air pollutants were compared to adopted relevant criteria. Where exceedances were observed, a quantitative assessment was undertaken.

The approach taken to the quantitative assessment of human health risks was in accordance with guidelines/ protocols provided by enHealth (2002), ANZECC and NH&MRC (as detailed in CSMS 1991, 1993, 1996 and 1998), ANZECC/NH&MRC (1992), NEPM (Schedule B(4), “Guideline on Health Risk Assessment Methodology”, 1999).

ES 1.2 Assessment Outcome

Criteria Pollutants (including Particulate Matter)

This assessment of criteria pollutants considered NO_2, PM_{10}, TSP, deposited dust and CO. In accordance with the *Approved Methods* (DEC 2005), the following species require the addition of background concentrations to peak predicted GLCs in order to generate a worst case cumulative concentration: NO_2, PM_{10}, TSP, deposited dust and CO. NO_2 and CO were shown to be within regulatory criteria.

Based on a contemporaneous PM_{10} assessment, the highest cumulative concentration was shown to be present at the south western corner of Lot 100 (Receptor 1) at a concentration of 51.7 µg/m^3, which

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marginally exceeds the regulatory criteria of 50 µg/m^3. The annual PM_{10}, deposited dust and peak cumulative TSP levels were however below criteria.

The particulate matter assessment is considered conservative, however, elevated concentrations of PM_{10} are likely adjacent to most construction sites where earthworks and large exposed areas are present. To ensure adverse impacts associated with particulate matter are not experienced by residents of Lot 100, it is suggested that dust minimisation procedures are adopted in the Construction Management Plan. This should include regular boundary monitoring to ensure construction operations from the Allied Feeds site and remediation activities from the Lednez site do not result in boundary concentrations of particulate matter in exceedance of regulatory criteria.

Odour

The boundary odour data from the Lednez and Allied Feeds sites were reviewed and it was noted that the majority of odour surveys recorded no detectable odour. Where odour was reported from the Lednez or Allied Feeds sites, community odour complaints were also generally recorded in the Rhodes Community Consultative Committee (RCCC) Meeting Notes.

It should, however, be noted that peoples' sensitivities vary, and that the new occupants of Lot 100 may include people with greater sensitivity than current residents or the personnel who have conducted the field odour surveys. .

Given the history of odour complaints during the remediation, in conjunction with the boundary monitoring data, it is expected that odour impacts above the DECC odour criteria (2 odour units) will occur at Lot 100. Continued boundary odour monitoring and the implementation of odour control measures, especially for the excavation of odorous materials, will assist in minimising odour complaints.

Air Toxics

A range of air toxics were considered from stack (based on maximum annual average and acute 1 hour emissions) and area sources (based on data from Summa canister monitoring) were identified at the Lednez site. An assessment of potential chronic and acute exposures by residents at Lot 100 has indicated that the calculated concentrations are below the adopted ambient air criteria (with the exception of chromium) and below acute response levels. The exceedances noted for chromium are from annual average stack emissions from the Lednez site.

The quantitative assessment of potential inhalation exposures associated with chromium emissions (as either Cr VI or Cr III) from the stack (based on lifetime exposures) for residents (adults, older children and younger children) has indicated that the risks to human health are low and acceptable.

Noise

The potential noise impacts of the decommissioning at the Allied Feeds site and construction activities at the Allied Feeds site and the remediation activities at the Lednez site on residents at Lot 100 have been assessed based on the information provided.

A determination of the noise criteria for this assessment is generally based on the following:

- A study of the varying sensitivities of the respective receiver locations; and
- The time duration of the various construction processes.

In establishing the noise criteria for this assessment, it should be noted that highly conservative criteria cannot be applied to a construction site in Sydney Metropolitan area as no construction site would fully comply with the criteria. A building construction site involves a series of complicated processes and activities over a relatively short period of time. Given that the majority of the construction work will occur in the open space, it is practically impossible to reduce noise emissions from these activities to a satisfactory level.

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In the past the NSW EPA has waived the conservative blanket criteria for constructions in Sydney area. For example, EPA has agreed to construction noise criteria of 30 dB(A) above background noise level for the M2 Motorway project even though the project involved quiet suburban areas.

This is a similar situation to the construction of Allied Feeds site where high level noise would be generated approximately for 4 weeks. In this assessment, it has been proposed that the project noise criteria be background + 20 dB(A) to 25 dB(A) for residents at Lot 100.

All construction work at the Allied Feeds site is to be carried out in accordance with AS2436-1981 *'Guide to Noise Control on Construction, Maintenance and Demolition Sites'* and the recommendations controlling noise and vibration stipulated in the Meriton's *'Construction Management Plan for Development at 42 Walker Street, Rhodes'*. Whilst construction work is to be carried out according to relevant guidelines, noise levels from the proposed operations during the daytime period are expected to exceed the noise limits occasionally due to the proximity of the receptor location (Lot 100) to the proposed construction activities at Allied Feeds site. It is, however, expected that noise impacts during the night-time period would not exceed the noise limits significantly, and sleep disturbance to residents is therefore not expected to occur.

Section 1 Introduction

1.1 General

URS Australia Pty Ltd (URS) has been engaged by Australian Remediation Services Pty Ltd (Meriton) to prepare a Human Health Risk Assessment (HHRA) for the residential occupation of Lot 100, 42 Walker Street, Rhodes. The whole of 42 Walker Street is referred to as the Allied Feeds site (see **Figure 1**) of which Lot 100 is the northernmost portion.

The Allied Feeds site has been undergoing remediation activities during which the complete construction of residential units within Lot 100 has occurred. Remediation activities on the site are currently in the final stages. Following completion of remediation the site will be decommissioned. It is proposed that residential occupation of Lot 100 will occur during the decommissioning phase, after the completion of the thermal treatment operations.

Adjacent to the Allied Feeds site, to the south is the Lednez remediation site which is currently undergoing remediation. Construction of high density residential apartments is also currently taking place on the northern portion of the Lednez site. The site layout is illustrated on **Figure 1**. For the purposes of this assessment it is assumed that the Lednez site will undergo remediation for a period of 3 years during the residential occupation of Lot 100.

The presence of residents in Lot 100 during the decommissioning of the adjacent Allied Feeds site and remediation of the Lednez site will involve potential exposure to airborne emissions from a range of sources including volatile chemicals originating from soil and soil treatment processes (stack emissions), dust, odour and noise emissions.

This assessment has been undertaken to assess the potential human health risks to residents residing in the proposed high density residential apartments on Lot 100. The assessment is limited to the receptors on Lot 100 and does not include any assessment of offsite conditions or offsite residential scenarios.

The remediation of the Allied Feeds site and Lednez sites are being managed by Thiess Services Pty Ltd (Thiess).

URS have previously completed Human Health Risk assessments for Lots 100 and 103 of the Allied Feeds site, for the Meriton construction workers building the residential development site (URS 2006, 2008a).

1.2 Scope and Objectives of Risk Assessment

Meriton have lodged a Section 96 (1A) application (reference MP05_0039) to the Canada Bay Council (reference PA 420/2007) for residential occupation of Lot 100, 42 Walker Street Rhodes during decommissioning of the Allied Feeds site and the continued remediation of the adjacent Lednez site. This risk assessment is required as part of the Section 96 application.

Based on the available information, the overall objective of the HHRA will be to provide a quantitative assessment of the potential risks to human health associated with residential occupation of apartments located at Lot 100, on the former Allied Feeds site, and adjacent to the remediation areas of the Lednez site. The scope of work includes:

- Calculation of ambient concentrations of volatile organic compounds and particulate matter within the residential units of Lot 100, using both dispersion modelling and site ambient monitoring data;
- Where required, undertake a quantitative assessment of risks to human health associated with key emissions;
- Provide a qualitative assessment of odour within Lot 100; and

- Provide a qualitative assessment of potential exposure to noise by residents within Lot 100.

1.3 Approach to Prediction of Ambient Concentrations at Lot 100

The assessment broadly followed guidelines contained in. *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (DEC, 2005).

The assessment involved the development of an air emissions inventory, compilation of meteorological and terrain data, dispersion modelling using CALPUFF and assessment of background air quality data. The air quality assessment comprised the following:

1. **Volatile Organic Compound (VOC) Assessment.** VOC were derived from two primary sources, namely the remediation stacks and area / fugitive sources. The stack sources (from Lednez) were modelled using the CALPUFF dispersion model in conjunction with measured emission rates to generate concentrations of VOC. Additionally, measured VOC in ambient air at the site boundary were assessed and considered to be representative of ambient concentrations of VOC resulting from area / fugitive sources at both the Allied Feeds and Lednez sites. These sources were then added to create a cumulative impact from both stack, and area/fugitive sources.

2. **Particulate Matter Assessment**. Particulate matter (dust) was modelled from a range of sources at both the Lednez and Allied Feeds site, to assess the likelihood of particulate matter exceedances at Lot 100.

3. **Odour Assessment**. A qualitative odour assessment investigating the likelihood of adverse odour impacts at Lot 100 from sources at Lednez and Allied Feeds.

The estimated air concentrations were compared with the DECC's impact assessment criteria (DEC, 2005). When concentrations of VOC were in excess of the impact assessment criteria, further assessment in the form of a Human Health Risk Assessment, was performed.

1.4 Approach to Noise Assessment

The approach to noise assessment will be:

- Review available noise data associated with the remediation activities of DTD and PTB at the adjacent Lednez site and the decommissioning and construction phase at the Allied Feeds site;
- Undertake a qualitative assessment to address potential noise impact of the aforementioned activities on residents at Lot 100; and
- Provide recommendations on mitigation measures to protect amenity of residents at Lot 100.

1.5 Approach to Human Health Risk Assessment

The approach taken to the assessment of human health risks will be generally in accordance with the protocols/ guidelines recommended by enHealth (Environmental Health Risk Assessment, Guidelines for Assessing Human Health Risks from Environmental Hazards, June 2004). These guidelines draw on and are supplemented by those provided by ANZECC and NH&MRC and detailed in the documents:

- The NEPM (Schedule B(4), Guideline on Health Risk Assessment Methodology, 1999);
- "The Health Risk Assessment and Management of Contaminated Sites" (CSMS 1991, 1993, 1996 and 1998 and enHealth 2004); and

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- ANZECC/NH&MRC (1992).

ANZECC and NH&MRC currently provide only general guidance for the completion of these tasks and, as such, the more detailed protocols and guidelines developed by the US EPA (1989) have been used to provide supplementary guidance.

In following this approach and in accordance with these types of risk assessments, the proposed HHRA is not an epidemiological study (which is a study of the distribution and causes of existing health related issues in the community). Rather, the assessment will provide an evaluation of the potential impact of exposure to site related chemicals on risks to human health using guidance recommended and endorsed by Australian regulators, in particular the NSW Department of Environment and Climate Change (DECC) and NSW Health.

Human health risk assessment can be divided into the following four prime tasks:

- Issue Identification/Data Evaluation (Section 2 of this report)
- Exposure Assessment (Section 6)
- Toxicity/Hazard Assessment (Section 6); and
- Risk characterisation (Section 6).

Section 2 Previous Investigations and Data Assessment

2.1 General

URS have been provided with various datasets from Thiess for the Lednez and Allied Feeds site, which are listed in **Section 2.2**. The assessment has been undertaken utilising the information made available to URS. It is noted that there is a large amount of data provided to URS which has no detail about how it was collected or background information such as laboratory reports. Identified data gaps are detailed further in **Section 2.7**.

2.2 Previous Investigations and Data Sources

To date there have been a number of assessments completed on the Allied Feeds and Lednez sites, information provided to URS to undertake this risk assessment is provided below:

- Airlabs Environmental (2008), *Monitoring conducted on the ECS Stack for Thiess Services in Rhodes*, April 2008;
- Airlabs Environmental (2008), Test Report No. JAN08009, *Dioxin & Furan Monitoring Conducted on the Thiess Services Direct Thermal Desorption Plant in Rhodes, Date of Testing: 18th January, 2008,* January 2008.
- Airlabs Environmental (2008), Test Report No. MAR08039, *Monitoring Conducted on the DTD Stack for Thiess Services in Rhodes, Date of Testing: 18th & 19th March, 2008,* April 2008.
- Airlabs Environmental (2008), Test Report No. APR08047, *Dioxin & Furan Monitoring Conducted on the Thiess Services Direct Thermal Desorption Plant in Rhodes, Date of Testing: 2nd April, 2008,* May 2008.
- Airlabs Environmental (2008), Test Report No. JUN08077, *Monitoring Conducted on the DTD Stack for Thiess Services in Rhodes, Date of Testing: 17th & 18th June, 2008,* July 2008.
- Airlabs Environmental (2008), Test Report No. JUL080104A, *Dioxin & Furan Monitoring Conducted on the Thiess Services Direct Thermal Desorption Plant in Rhodes, Analysis Separation Report, Date of Testing: 31st July, 2008,* August 2008.
- Airlabs Environmental (2008), Test Report No. AUG08117, *Dioxin & Furan Monitoring Conducted on the Thiess Services Direct Thermal Desorption Plant in Rhodes, Date of Testing: 21st August, 2008,* September 2008.
- Airlabs Environmental (2008), Test Report No. MAY08066, *Dioxin & Furan Monitoring Conducted on the Thiess Services Direct Thermal Desorption Plant in Rhodes, Analysis Separation Report, Date of Testing: 29th May, 2008,* October 2008.
- Airlabs Environmental (2008), Test Report No. SEP0812127, *Monitoring Conducted on the DTD Stack for Thiess Services in Rhodes, Date of Testing: 10th & 17th September, 2008,* October 2008.
- ENSR/AECOM, Screening Human Health Risk Assessment: Volatile Organic Compounds in Air at the Lednez Remedition Site, Rhodes, Sydney, 30th October 2007;
- Holmes Air Sciences, Letter Report Re: Summary of analysis of SVOC and Dioxin monitoring results, addressed to Ms Cheryl Holden (Thiess Services Pty Ltd) dated 20th May 2008;

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- Holmes Air Sciences, Letter Report Re: Summary of VOC modelling results at the East and South boundaries, addressed to Ms Cheryl Holden (Thiess Services Pty Ltd) dated 20th May 2008;
- Holmes Air Sciences, Letter Report Re: Summary of modelling for modified Lednez proposal, addressed to Jo Robertson (HBI Pty Ltd) dated 17th August 2006;
- Holmes Air Sciences, Final Report "Air Quality Monitoring, Review and summary of dust monitoring in 2006 Rhodes Peninsula site" Prepared for Thiess Services, dated August 2007;
- Holmes Air Sciences, "Odour Assessment, Homebush Bay Remediation", prepared for Thiess Services Pty Ltd, February 2006;
- PB, Lednez, Homebush Bay and Allied Feeds Site Remediation, Occupational Health and Safety Environmental Monitoring, July 2005 and April 2006 (CD copy);
- Environmental Protection Authority, Environmental Protection Licence with Thiess Services Pty Ltd (Licence Number 12366);
- PB, Memorandum Re: OHS monitoring results- Meritons @Allied Lot 100, addressed to Benjy Levy (Meriton) from Shane Harris (PB), dated Friday 18th May 2007;
- HLA Envirosciences Pty Limited, Emission Testing Report, Former Allied Feeds Homebush, March 2007, dated 2nd April 2007;
- HLA Envirosciences Pty Limited, Emission Testing Report, Former Allied Feeds Site Homebush, May 2007, dated 19th June 2007;
- HLA Envirosciences Pty Ltd (2007), *Emission Testing Report – Allied Feeds Site August 2007,* November 2007;
- Thiess Services Pty Ltd (2005), *Remediation of the Former Allied Feeds Site - Air Quality Management Plan,* April 2005;
- Parsons Brinckerhoff (2002), *Remediation of Lednez Site, Rhodes and Homebush Bay Environmental Impact Statement*, December 2002;
- URS (2005) *Final Remediation Action Plan for the Former Allied Feeds Site, 42 Walker Street, Rhodes;*
- HLA Envirosciences Pty Ltd, *Emission Testing Report – Allied Feeds Site August 2007*, November 2007;
- Thiess Services (2006) '*Application to modify existing Development Consent, Remediation of the Lednez Site, Rhodes and Homebush Bay*', September 2006;
- Wilkinson Murray Pty Ltd (2006), Appedix F *'Lednez Site – Section 96 Application'* of '*Application to modify existing Development Consent, Remediation of the Lednez Site, Rhodes and Homebush Bay'*, September 2006;
- Thiess Services Pty Ltd (2005) *Remediation of the Former Allied Feeds Site - Air Quality Management Plan*, April 2005;
- URS (2006), *'Human Health Risk Assessment for on Site Construction Workers former Allied Feeds Site'*, June 2006;
- URS (2007) '*Addendum to Human Health Risk Assessment for Onsite Construction Workers, former Allied Feeds site Rhodes'* URS, June 2007;

- Wilkinson Murray Pty Ltd (2005), '*Remediation of the former Allied Feeds Site, 42 Walker Street, Rhodes - Revised Noise Impact Assessment, Section 96 Application'*, December 2005;
- Wilkinson Murray Pty Ltd (2006), *'Allied Feeds Site – DEC Request for Further Information regarding Background Noise Level Measurements'*, April 2006;
- Wilkinson Murray Pty Ltd (2006), *'Allied Feeds Site – DEC Request for Further Information regarding predictions to the residential buildings associated with the Statewide Development Site'*, April 2006;
- Meriton Apartments Pty Ltd (2007), *'Construction Management Plan for Development at 42 Walker Street, Rhodes'*, July 2007;
- Thiess Services (2008a) *Bay Remediation Management Protocol. Incorporating the results of the Trial of the Sediment Containment System. Homebush Bay*. January 2008;
- Thiess Services (2008) *'Remediation of the Former Allied Feeds Site - Decommissioning Environmental Management Plan'* October 2008; and

- A range of environmental monitoring data has also been provided either provided directly to URS, or downloaded from (available http://www.rhodesremediation.com.au/). This data exists in the form of spreadsheets and text files and includes:
  - Boundary Photo-Ionisation Detector (PID) VOC monitoring;
  - Boundary Odour Monitoring;
  - Boundary Dust Monitoring; and
  - Boundary VOC Monitoring using Summa canisters.

2.3 VOC Data

This assessment has incorporated ambient monitoring performed by Parsons Brinkerhoff Pty Ltd (PB) on behalf of Thiess as part of the environmental monitoring program for the Lednez Site. This data has been incorporated to the Lot 100 HHRA at the request of the NSW DECC, as part of discussions considering the risk assessment methodology.

URS have been provided with a spreadsheet of ambient air sampling undertaken between September 2007 and November 2008 along the southern and eastern boundary of the Lednez site at four locations (refer to **Figure 1** for locations). This data includes monitoring details such as location, site operations at the time of sampling, sample collection start and stop times, as well as analyte concentrations. URS understand that the Summa canister analysis is performed by SGS Australia Pty Ltd in Alexandria, who are NATA accredited for the TO-15 method. The analytical results from SGS have not been provided, therefore URS have been unable to determine the accuracy and precision of the data set provided by PB.

In addition to this data, VOC emissions from the Lednez Pre-Treatment Building (PTB) and Direct Thermal Desorption Plant (DTD) stacks were sourced from the stack testing reports listed in **Section 2.2**. This testing has been performed by NATA accredited laboratories, in accordance with the Environmental Protection Licence (EPL) for the respective sites. A more detailed analysis of the stack emission data is provided in **Appendix B**.

2.4 Particulate Matter Data

Particulate matter emissions from the Lednez Pre-Treatment Building (PTB) and Direct Thermal Desorption Plant (DTD) stacks were sourced from the stack testing reports listed in **Section 2.2**. This testing has been performed by NATA accredited laboratories, in accordance with the Environmental Protection Licence (EPL) for the respective sites. A more detailed analysis of the stack emission data is provided in **Appendix B**.

Whilst emission rates of particulate matter for construction activities were not provided, URS were provided with details of construction activities by Thiess. These activities were used as the basis for estimating emissions of particulate matter during these works.

In addition, background concentrations of Particulate Matter less that ten microns in diameter PM_{10} are added to the predicted GLC from the operations to generate a cumulative concentration (DEC, 2005). Background concentrations are generally obtained from NSW EPA monitoring stations, however, for this assessment, PM_{10} data from Blaxland Road, located opposite the Lednez site has also been included in this assessment.

2.5 Odour Data

URS have been provided by Thiess with the Lednez and Allied Feeds site boundary odour monitoring data undertaken between September 2007 and January 2009. It is understood the odour monitoring was performed using a nasal ranger, which is a portable field odour measurement device. This odour monitoring was performed as part of the environmental monitoring program for the Lednez / Allied Feeds site(s).

The monitoring data provides details of the boundary locations where odour monitoring was performed, estimated odour concentrations (referred to as dilution units) and where relevant, odour character. The data was generally collected over a 20 to 30 minute period at various times throughout the day on every weekday excluding Sundays. The monitoring was undertaken from the northern, southern, eastern and western boundaries of both the Lednez and Allieds Feeds sites. In addition to the boundary odour monitoring data, Rhodes Community Consultative Committee (RCCC) Meeting Notes (available http://www.rhodesremediation.com.au/) were also examined for evidence of community odour complaints.

2.6 Noise Data

URS have been provided by Thiess with the noise impact report ('*Remediation of the former Allied Feeds Site, 42 Walker Street, Rhodes - Revised Noise Impact Assessment, Section 96 Application'*, December 2005*)* prepared by Wilkinson Murray Pty Ltd which considers source noise data associated with the operations of Direct Heated Thermal Desorption Plant (DTD) and Pre-Treatment Building (PTB) at the adjacent Lednez site.

Results of the background noise surveys conducted at residential locations in Blaxland Road and Meadow Crescent for the purpose of noise assessment of the remediation activities at the Allied Feeds site have also been referenced from the aforementioned Wilkinson Murray's noise assessment report.

Noise criteria applicable to the remediation activities of the Lednez site for residents at Lot 100 have been referenced from the Thiess Services report '*Application to modify Development Consent, Remediation of the Lednez Site, Rhodes and Homebush Bay'*(September 2006).

No noise data associated with the proposed decommissioning activities at the adjacent Meriton development site (Lot 101, 102, 103 and 104) has been provided with reference to Lot 100.

A construction noise and vibration management plan prepared by Acoustic Logic Consultancy has been received from Meriton Apartments Pty Ltd as a part of their Construction Management Plan prepared to protect amenity of noise sensitive receptors surrounding the construction of Lot 100 site. It provides a qualitative assessment which considered the noise and vibration impacts of the proposed construction activities at Lot 100 site on residents in Blaxland Road. Mitigation measures of potential noise and vibration affecting these residents on Blaxland Rd have also been provided within the report. The report however, does not provide detailed calculations or modelling of potential noise and vibration impacts on residents at Lot 100 (refer to **Table 2.1**).

2.7 Data Gaps

Detailed in **Table 2-1** below are data gaps identified by URS during the review of the available information.

Table 2-1 Identification of Data Gaps

<table>
<tr><th>Data Gap</th><th>Works Completed</th><th>Significance within Assessment</th></tr>
<tr><td>No VOC data on Lot 100 boundary representative of ambient air quality</td><td>VOC monitoring has been completed on the southern boundary of the Lednez site. This is a significant distance from Lot 100 (~400 meters), however in the absence of data, these concentrations have been adopted</td><td>Low- As samples are collected on southern boundary (closer to the Lednez ground source emissions) the concentrations are likely to be an overestimate of those on the Lot 100 boundary.</td></tr>
<tr><td>VOC concentrations from Summa canisters</td><td>URS have been supplied with spreadsheets containing concentrations at the Lednez southern boundary. There is no way to verify that these results are correct as URS have not been supplied with the laboratory reports for the analysis or a detailed methodology/ report of the sampling undertaken. It is not known if any laboratory limit of reporting (LORs), holding times, sample collection problems may have occurred. URS cannot verify that the Summa canisters were received at adequate vacuum pressures by the laboratory. There is no information about laboratory QA/QC which may influence the adoption of data within this assessment such as method blanks and laboratory control and laboratory duplicate samples.</td><td>High- The data has been used in the assessment of potential risks to residents on Lot 100 following a request from the DECC to use the data. The potential for increased or decreased concentrations reported is unknown as URS have not been supplied with adequate information to make a detailed assessment.</td></tr>
<tr><td>Noise data associated with decommissioning activities at Allied Feeds site</td><td rowspan="2">It is not possible to accurately predict potential noise and vibration impacts of the decommissioning and construction activities at the Allied Feeds on residents at Lot 100 as URS has not been provided with noise source data. In the absence of the data, in-principle recommendations on noise mitigation measures have been made.</td><td>Low – It is expected that the decommissioning activities would not generate significant noise affecting residents at Lot 100. The activities would also be limited to daytime period (7am – 6pm).</td></tr>
<tr><td>Noise data associated with construction of residential buildings at Lot 101, 102, 103 and 104</td><td>Med – Noise emissions from the proposed construction is expected to exceed the construction noise limits from time to time during construction period. The potential maximum noise emission levels and the duration of the activities causing noise generation are unknown as URS has not been provided with sufficient information for detailed calculations. However, the recommended noise and vibration mitigation measures provided in the Meriton's Construction Management Plan can also be applied to protect amenity of residents at Lot 100. It is also noted that the construction activities will also be limited to daytime period (7am – 6pm).</td></tr>
<tr><td>No sediment excavation VOC / odour emissions data</td><td>Odours were reported to be limited to site boundary during a trial excavation and ambient air VOC monitoring adjacent to storage trenches (containing dredged</td><td>Med – excavated sediment has the potential to be significantly odorous, and given that the sediment will be stored on site, adverse odour impacts could occur. However,</td></tr>
</table>

Data Gap	Works Completed	Significance within Assessment
	sediments) showed non-detectable concentrations of measured VOCs.	control measures can be implemented to limit surface / fugitive emission of the odour source associated with this process. Transient high concentrations of VOC may occur during excavation, however, the trial suggests VOC levels will be relatively low.
No ambient air PAH (Polycyclic Aromatic Hydrocarbon) Monitoring Data	Stack emission data for PAH have been provided and modelled, however, sufficient ambient air concentrations of PAH have not been collected in order to reflect emissions associated with excavations and diffuse sources..	**Moderate -** The accumulative concentrations of PAHs from stack and ground source emissions is unknown. The assessment has considered the available data which did not include analysis of PAHs from ambient air monitoring conducted on the southern boundary of Lednez site. Therefore the potential cumulative impacts to residents on Lot 100 cannot be determined.
Minimal data from the Lednez DTD	URS has been provided with initial test runs from the Lednez DTD. URS does have several months of Allied Feeds DTD stack emission data.	**Low** – Based on the similarity in operation of the Lednez DTD to the Allied Feeds DTD and based on the assumption that the site soils are similar (with respect to contamination), the Lednez stack emissions are likely to be similar to the Allied Feeds DTD emissions.

Section 3 Assessment Methodology

3.1 General

The assessment of potential health risks to residents on Lot 100 requires the consideration of potential exposures from adjacent remediation sites at Allied Feeds and Lednez. Detailed below is the assessment methodology adopted for the assessment of exposures to residents.

3.2 Sources of Exposure

The assessment has involved the consideration of potential exposures by residents at Lot 100 based on available data. The assessment has involved consideration of the following sources/activities:

- VOC emissions from ground sources and stack sources at Lednez;
- Dust generation from the remediation activities during the remediation activities at Lednez and decommissioning and construction activities of Allied Feeds;
- Odours from the remediation activities at Lednez and during decommissioning of Allied Feeds;
- Noise sources from both the remediation activities at Lednez and the decommissioning and construction activities at Allied Feeds;

The following section presents additional detail on the approach adopted to estimate exposure concentrations relevant to these sources/activities.

3.3 Dispersion Modelling Method

3.3.1 General

Dispersion modelling involves the combining of a range of data sources (this includes VOCs, stack emissions and fugitive dust sources). The meteorological data prepared for use in this assessment in provided in **Appendix A** and considered suitable for use in this assessment. The emission sources for particulate matter and VOC are described in detail in **Appendices B** and **C** respectively. The background concentration data used to generate cumulative concentrations of modelled pollutants is discussed in the following section (**Section 3.3.2**). Additionally, the methods for assessing VOCs, particulate matter and odour are discussed in subsequent sections (**Sections 3.3.3** to **3.3.5**). The dispersion modelling considered concentrations at 100 receptors on Lot 100, from ground level up to the top of the apartments (1m, 9m, 17m, 25m, and 33m elevation).

3.3.2 Background Concentrations of Criteria Pollutants

Background air quality is generally a function of regional industrial and residential air emission sources. The *Approved Methods* (DEC, 2005) requires that the peak concentration of a criteria pollutant measured by an appropriate ambient air quality monitoring station is used to represent the background concentration of that pollutant for a region. This results in a conservative assessment as concentrations of an individual pollutant may vary over different time scales. While the maximum concentration of a pollutant may be elevated due to unusual events (for example PM_{10} is elevated during dust storms and bushfires), the concentrations for the remainder of the year may remain low, hence the use of the maximum background value provides a conservative measure of impact.

The background data for Nitrogen Dioxide (NO_2) PM_{10}, Total Suspended Particulate (TSP) and Carbon Monoxide (CO) was taken from the DECC air monitoring site at Rozelle (2007). The Rozelle station was chosen as it is one of the closest monitoring station to the Lednez / Allied Feeds site, situated approximately 8km east of the Allied Feeds site, is also located close to the Parramatta River and is considered to provide representative background concentrations. Where data from Rozelle was not available, data from Chullora was used. Similar to Rozelle, the Chullora monitoring station is location approximately 8 km from the Lednez / Allied Feeds site. At both monitoring locations, 2007 data is only available as data for 2008 has not yet been released by DECC. Summary background data used in this assessment is provided in **Table 3-1**.

It should be noted that PM_{10} data is collected from Blaxland Road, adjacent to the site. Given that the PM_{10} measurements at this location are likely to include emissions of particulate from the Lednez / Allied Feeds sites, it would be considered conservative to assume these data as being representative of background PM_{10} in the area.

Table 3-1 Summary of Background data obtained from Rozelle used in Air Quality Modelling - 2007

Species	Averaging Time	Monitoring Station	Maximum Background Concentration (µg/m³) A	Air Quality Criteria (µg/m³)
NO_2	1 hour	Rozelle	103	246
	Annual average	Rozelle	24	62
PM_{10}	24 hour	Blaxland Road C	45.8 B	50
	Annual	Blaxland Road C	17.6	30
TSP	Annual	NA	35.2 c	90
Deposited dust	Annual (incremental)	NA	NA	2 g/m²/month
	Annual (total)	NA	2 g/m²/month C	4 g/m²/month
CO	15 minute	Rozelle	9500	100,000
	1 hour	Rozelle	3250	30,000
	8 hour	Rozelle	2070	10,000

Note:
Concentrations in µg/m³ unless otherwise stated.
NA = not applicable
A: Concentrations converted from pphm / ppm to µg/m³ and assumed to be 0^0C.
B: PM_{10} from Blaxland Road (adjacent to the site) has been used in a contemporaneous assessment. The value presented is associated with the highest predicted (contemporaneous) GLC for PM_{10} and is further discussed in **Appendix B**.
C Refer to **Appendix B** for details.

Estimation of pollutant concentrations for averaging periods less than one hour

Where pollutant concentrations were required to be assessed for averaging times less than one hour, namely for sulphur dioxide and CO, as presented in **Table 3-1**, Equation 1 was used (Victoria EPA, 2005).

$$C_t = C_{60}\left[\frac{60}{t}\right]^{0.2} \quad \text{…[Equation 1]}$$

Where:

C_t = concentration of pollutant at time t

C_{60} = concentration of pollutant based on averaging time of 60 minutes;

t = time (in minutes)

3.3.3 Volatile Emission Sources

The estimation of VOC concentrations at Lot 100 relied upon both ambient monitoring data, and dispersion modelling. The data and modelling were incorporated as follows:

- Ambient monitoring data was assumed to be representative of pollutant concentrations occurring at Lot 100 as a result of emissions from diffuse sources on the Lednez Site (e.g. excavations and fugitive emissions).
- Dispersion modelling was used to calculate pollutant concentrations occurring at Lot 100 as a result of emissions from stack sources on the Lednez Site. The monitoring and modelling results were then added to form a cumulative VOC impact.

Ambient Monitoring

A representation of annual average non-stack VOC concentrations at Lot 100 has been calculated by averaging all 24-hour summa canister monitoring data. Only analytes that were detected above the Limit of Reporting (LOR) in any one of the 26 samples were included in the average.

A representation of peak 1 hour average non-stack VOC concentrations at Lot 100 has been calculated using the peak results for each of analyte in all of the 8-hour and 24-hour summa canister monitoring. Worst case peak-to-mean ratios of 8 and 24 were used to adapt the 8-hour and 24-hour (respectively) sampling results to represent 1-hour concentrations. For example, 1ppm of toluene collected using an 8 hour summa canister would be assumed in this investigation, to result in an peak 1 hour average concentration of 8 ppm. Only analytes that were detected above the LOR in any one of the 55 samples were included. Full detail of the data and methodology for its incorporation is included in **Appendix D**.

Dispersion Modelling

Dispersion modelling of stack sources was performed using the CALPUFF dispersion modelling package in conjunction with emission rates derived from the stack testing reports listed in Section 2.2, and onsite meteorological data. The model results were processed to calculate acute (1hr) impacts as well as chronic (annually averaged) impacts. Full detail of the stack modelling methodology is included in **Appendix C**.

3.3.4 Particulate Matter

The particulate matter assessment was undertaken to represent likely site operations from both the Lednez and Allied Feeds site over the next two years. URS considered a scenario consisting of remediation activities occurring at Lednez and construction activities at Allied Feeds to be representative of the activities likely to occur during this period. To perform the assessment, URS required particulate matter emission rates for significant sources on both the Lednez and Allieds Feeds site. URS were not provided with area source emission rates for the sources on either the Lednez or Allied Feeds site which included: excavation, materials handling, roadways, exposed stockpiles etc. Emissions from these sources were derived from site operational data provided by Thiess and Meriton and emission factors such as AP-42 (US EPA 2006) / NPI (NPI 2001) emission factors. The emission factors and corresponding emission data are detailed in **Appendix B.**

Stack emissions of particulate matter (TSP) were provided for the Lednez PTB and Lednez DTD. TSP comprise a range of coarse and fine suspended particulate matter, which includes the PM_{10} fraction. As the TSP emissions were derived from a combustion source (combustion sources generally emit particles smaller than PM_{10}) which was subsequently passed through a bag house to further remove particulates., The particulates were considered to comprise of a dominantly fine fraction. Consequently the TSP emissions were presumed comprise only the fine fractions, namely PM_{10}.. The emission sources and corresponding emission data are detailed in **Appendix C**.

3.3.5 Odour

Boundary monitoring data from both the Lednez and Allied Feeds site were reviewed and compared against RCCC Meeting Note reports to establish whether the boundary monitoring method was consistent with community complaints. The available information was used to determine the potential for odour impacts at Lot 100.

3.4 Noise

No background noise surveys have been conducted for residents at Lot 100, noise limits for the residents can however be referenced from the Thiess Services report (‘*Application to modify Development Consent, Remediation of the Lednez Site, Rhodes and Homebush Bay’,* September 2006). Noise limits have originally been established for residents surrounding the Lednez site in order to assess noise impacts of remediation activities at the Lednez site.

At the time of occupancy of residents at Lot 100, the background noise levels may have already been elevated marginally since the last background noise survey in 2005 due to the recent changes in landuse surrounding the area with residential developments being completed and increased traffic movements.

The primary noise sources affecting residents at Lot 100 would be the decommissioning and construction activities at the Allied Feeds site during daytime period and the remediation activities at the Lednez site during night time period. Noise impacts of the remediation activities at the Lednez site on residents at Lot 100 during daytime period would not expected to be noticeable as the noise is expected to be significantly lower than the construction noise at the Allied Feeds site.

The predicted noise emission levels of the remediation activities at the Lednez site, which have been provided in the previous noise reports, have been reviewed.

As stated in **Section 2.7**, in the absence of noise data of the decommissioning and construction activities at Allied Feeds site, a qualitative assessment has been undertaken. The findings are provided in **Section 5** of this report.

3.5 Exposures to Contaminated Soil, Groundwater and Surface Water

The Allied Feeds site is subject to a statutory site audit (under the CLM Act 1997) following the remediation works completed at the site. Brad Eismen (HLA-ENSR) is the appointed NSW EPA accredited site auditor. A site audit statement has been prepared for Lot 100 in the subdivision of DP 1049649. The site audit statement has confirmed that the site is suitable for high density residential (ie building with basement carpark) and recreational open space with noted conditions. The residential development is high density with minimal access to soils (ie backyards). There will be open space areas which are between residential buildings on the site, however there is limited access to any potential contamination as the site has been remediated in accordance with the remediation action plan and the site has been certified to be suitable for the mixture of residential and parkland use. Therefore potential exposures to concentrations of chemicals remaining within soil and groundwater on Lot 100 will not be considered within the assessment.

The residents of Lot 100 will not have access to other areas of the site undergoing remediation/construction as these areas will be fenced with appropriate security controls.

The residents will not have access to surface water within and surrounding the site that may be contaminated as part of the remediation activities. Whilst remediation is still occurring, it has also been considered that contact with surface water or sediment on the western boundary is also unlikely and therefore will not be considered.

3.6 Potential Exposure during Allied Feeds Decommissioning

The Decommissioning Environmental Management Plan (Thiess Services, 2008) provides the framework, timeline, practices and procedures for the decommissioning of the Allied Feeds site. Specifically the Plan considers the decommissioning of the PTB, DTD, waste-water treatment plant (WWTP) and general site facilities.

The proposed works to be undertaken as part of this decommissioning phase were considered to comprise transient and minor activities and unlikely to cause significant emissions. In addition, management plans or control measures were documented for odour, particulate matter (dust) and hazardous materials that could give rise to VOC emissions. Consequently the works associated with the decommissioning phase of the Allied Feeds site were not included in the VOC, particulate matter, odour or noise components of this investigation.

3.7 Potential Exposure During Sediment Remediation

Homebush Bay sediment is proposed to be excavated as part of the remediation of the Lednez site. The works will involve excavation, transfer of excavated sediment to storage trenches located on the Lednez site, reinstatement with replacement material and associated works such as air quality and water quality monitoring. A sediment excavation trial conducted by Thiess (Thiess, 2008a) showed limited adverse odour impact at the Lednez site boundaries. Additionally, air analysis using Summa canisters (8 hour and 24 hour) located adjacent to the storage trenches showed no detections of VOCs. Based on this information, it was considered that odorous and VOC emissions from the excavation process, including on site storage were likely to be negligible, consequently this source was omitted from inclusion in this investigation.

Section 4 Air Quality Assessment

4.1 General

This assessment considered NO_2, PM_{10}, TSP, deposited dust and CO. As stated in the *Approved Methods* (DEC 2005), the following species require the addition of background concentrations to peak predicted GLCs in order to generate a worst case cumulative concentration: NO_2, PM_{10}, TSP, deposited dust and CO. The worst case cumulative concentrations for the nominated species are provided **Section 4.2**. The predicted concentrations were below the adopted criteria, with the exception of PM_{10} and deposited dust, which is further discussed in **Section 4.2.2**. In addition, the qualitative odour discussion is provided in **Section 4.3**.

The *Approved Methods* (DEC, 2005) suggest that other toxic air pollutants be treated slightly differently to the pollutants mentioned above i.e. toxic air pollutants are to be assessed based only on the incremental concentration using a 99.9% frequency[A]. Given the potentially hazardous nature of the compounds present, URS estimated GLC of toxic pollutants using a more conservative approach than the approach suggested in DEC (2005). The URS method is detailed in **Appendix D**. The results of the dispersion modelling of chronic and acute concentrations of toxic air pollutants are provided in **Appendices E** and **F** respectively. The HHRA comprising an assessment of chronic and acute exposures to the toxic air pollutants is detailed in **Section 6**.

4.2 Air Quality Results for Criteria Pollutants

Table 4-1 provides the modelling results for criteria pollutants. Predicted VOC GLC have been compared to adopted ambient air and acute screening criteria as outlined in **Section 6**. It should be noted that concentrations of NO_2 were estimated using the Janssen equation, as detailed in **Section 4.2.1**.

Table 4-1 Summary of modelled results for impact assessment criteria pollutants

Species	Averaging Time	Maximum Background Concentration (µg/m³)	Incremental Impact (µg/m³)	Cumulative Impact (µg/m³)	Air Quality Criteria (µg/m³)
NO_2	1 hour	103	61	164	246
	Annual	24	3.1	27.1	62
PM_{10}	24 hour	45.8	5.9	51.7	50
	Annual	17.6	6.1	23.7	30
TSP	Annual	35.2	18.9	54.1	90
Dust Deposition	Annual	2 g/m²/month [A]	0.89 g/m²/month	2.89 g/m²/month	4 g/m²/month
CO	15 minute	4300	4	4304	100,000
	1 hour	3250	3	3253	30,000
	8 hour	2070	1	2071	10,000

Note:
- Concentrations in µg/m³ unless otherwise stated.
- Concentrations converted from pphm / ppm to µg/m³ and assumed to be 0°C.
- 1 hour NO_2 concentrations estimated using the Janssen equation, as described in **Section 4.1.1**.
- Sulfur dioxide has been excluded from this assessment as it is not included in the list of analytes to be measured from the stacks.
- 15 minute concentrations of CO (both background and incremental) have been based on 1 hour averaged data and extrapolated using the power law, which is further discussed in **Section 3.3.2**.
- Maximum contemporaneous PM_{10} impact presented, as discussed in **Appendix B**.
A - Referenced from Holmes Air Sciences (2003)

[A] For 1 hour averaged (acute) assessment of species, a 100% frequency refers to the highest predicted concentration of a modelled year, whereas the 99.9% frequency refers to the 9th highest concentration in a modelled year i.e. 99.9th percentile of 8766 hours.

4.2.1 NO/NO_2 Conversion Calculations

The emission rates of oxides of nitrogen are modelled as total NO_X, which includes nitrogen dioxide (NO_2), nitric oxide (NO) and traces of nitrous oxide (N_2O). The principal species of concern, in terms of human health effects, is NO_2 and it is this compound which has relevant ground level guidelines. While NO_2 will only make up a small proportion of the total NO_X emitted by the sources at the point of discharge, the NO_2/NO_x ratio will increase as the plume travels downwind as NO in the plume is oxidised to form additional NO_2.

DEC (2005) proposes three methods for assessing NO_x impacts, which are listed in order of increasing complexity. A summary of the methods is discussed below.

1) ***Method 1: 100% Conversion of NO to NO_2.*** This method assumes all NO_X emissions are emitted as NO_2 and that the highest recorded background NO_2 level is constant;

2) ***Method 2: NO to NO_2 conversion limited by ambient ozone concentration (OLM)***. This method presumes ambient ozone will react with NO to form NO_2; and

3) **Method 3: NO to NO_2 conversion using empirical relationship. (The Janssen Method)**. This method relies on the use of various atmospheric parameters. They present the following relationship, shown as Equation 2, for estimating NO_2/NO_x ratios in the plume based on the distance downwind from the source.

$$NO_2/NO_x = A(1-\exp(-\alpha x)) \qquad \text{…[Equation 2]}$$

Where:

x = distance downwind of plant (km)

α and A are dependent on the season, wind speed and background ozone concentrations. For the purpose of this study, α and A of 0.8 and 0.93 were chosen.

This relationship (Method 3) has been used to convert the maximum downwind NO_2/NO_x concentrations predicted by the modelling to enable comparison with ambient air quality guidelines (as presented in **Table 4-1**).

4.2.2 Particulate Matter

Based on a contemporaneous PM_{10} assessment, it was predicted that one additional exceedance of regulatory criteria would occur. This exceedance consisted of a cumulative concentration of 51.7µg/m^3 at ground level at the south west corner of Lot 100 and was dominated by a high background level of 45.8µg/m^3. The use of these background data is considered conservative, as it was measured near to the Allied feeds and Lednez sites at a time during which remediation activities (which were also represented in the modelling) were occurring. TSP and deposited dust levels were below criteria.

The particulate matter assessment is considered conservative, as detailed in **Appendix B**, however, elevated concentrations of PM_{10} are likely adjacent to most construction sites where earthworks and large exposed areas are present. To ensure adverse impacts associated with particulate matter are not experienced by residents of Lot 100, it is suggested that dust minimisation procedures are adopted in the Construction Management Plan. This should include regular boundary monitoring to ensure construction operations on the Allied Feeds site and remediation activities on the Lednez site do not result in boundary concentrations of particulate matter in exceedance of regulatory criteria.

Section 4 Air Quality Assessment

4.3 Odour

The boundary odour data from the Lednez and Allied Feeds site were reviewed and it was noted that the majority of odour surveys recorded no detectable odour. Where odour was reported from the Lednez or Allied Feeds sites, community odour complaints were also generally recorded in the Rhodes Community Consultative Committee (RCCC) Meeting Notes.

It should, however, be noted that peoples' sensitivities vary, and that the new occupants of Lot 100 may include people with greater sensitivity than current residents or the personnel who have conducted the field odour surveys.

Given the history of odour complaints during the remediation, in conjunction with the boundary monitoring data, it is expected that odour impacts above the DECC odour criteria (2 odour units) will occur at Lot 100. Continued boundary odour monitoring and the implementation of odour control measures, especially for the excavation of odorous materials, will assist in minimising odour complaints.

Section 5 Noise Assessment

The potential noise impacts of the decommissioning at the Allied Feeds site and construction activities at the Allied Feeds site and the remediation activities at the Lednez site on residents at Lot 100 have been assessed based on the information provided.

A determination of the noise criteria for this assessment is generally based on the following:

- A study of the varying sensitivities of the respective receiver locations; and
- The time duration of the various construction processes.

In establishing the noise criteria for this assessment, it should be noted that highly conservative criteria cannot be applied to a construction site in Sydney Metropolitan area as no construction site would fully comply with the criteria. A building construction site involves a series of complicated processes and activities over a relatively short period of time. Given that the majority of the construction work will occur in the open space, it is practically impossible to reduce noise emissions from these activities to a satisfactory level.

In the past the NSW EPA has waived the conservative blanket criteria for constructions in Sydney area. For example, EPA has agreed to construction noise criteria of 30 dB(A) above background noise level for the M2 Motorway project even though the project involved quiet suburban areas.

This is a similar situation to the construction of Allied Feeds site where high level noise would be generated approximately for 4 weeks (during foundation and basement carparking construction which would involve typical heavy weight excavation and construction processes) and in some cases construction activities would occur in proximity of residents at Lot 100. In this assessment, it has been proposed that the project noise criteria be background + 20 dB(A) to 25 dB(A) for residents at Lot 100.

With respect to the night time predicted noise levels, it is expected that noise impacts during this period would not exceed the noise limits significantly, and sleep disturbance to residents is therefore not expected to occur. Noise levels from the proposed operations during daytime period (7am to 6pm) are expected to exceed the noise limits occasionally due to the proximity of the proposed construction activities at Lot 100 site.

Where a particular activity or construction equipment is found to generate excessive noise or vibration levels, the noise and vibration mitigation measures specified in the *'Construction Noise and Vibration Management Plan for Development at 42 Walker Street, Rhodes'* prepared by Acoustic Logic Consultancy for Meriton Apartments (July 2007) should be followed including establishment of direct communication with affected parties that may be potentially impacted upon.

All work is to be carried out in accordance with AS2436-1981 *'Guide to Noise Control on Construction, Maintenance and Demolition Sites'* and the recommendations controlling noise and vibration stipulated in Meriton's *'Construction Management Plan for Development at 42 Walker Street, Rhodes'*.

Section 6 Human Health Risk Assessment

6.1 General

The consideration of potential risks to residents at Lot 100 has involved the review of the available data as listed in **Section 2.2** of this report, with consideration of dust and VOC data and stack emissions modelling for receptors located at Lot 100.

6.2 Key Issues

Based on the assessment of the available data, the following potential exposures have been considered in the assessment of potential human health risks to receptors on Lot 100.

- Inhalation of VOCs from excavations and ground source emissions from the Lednez site. This assessment has been conducted using summa canister measurements along the southern boundary of Lednez as representative of concentrations present at Lot 100;
- Inhalation of chemicals from the Lednez Stack. This assessment is based on the stack emission modelling conducted by URS and detailed further in **Section 4**; and

The consideration of potential risks to residents at Lot 100 has considered the total exposure from inhalation risks from stack emissions modelling and ground source emissions on the site from excavation and remediation activities. The assessment has considered potential (acute) short term and chronic (long term) health effects as detailed in **Sections 6.3** and **6.4**. These sections present and evaluation of the potential for these exposures to be of significance with respect to human health. Where there is the potential for significant exposures, these have been further quantified in **Section 6.5**.

The assessment of inhalation risks from both chronic and acute exposures has assumed that the concentration of contaminants present in the indoor air is equal to those present in outdoor air (i.e. no dilutions have been applied).

6.3 Review of Chronic Exposures

The chronic exposures (long term) via inhalation have been assessed for the future residents at Lot 100 utilising the stack emissions assessment (**Section 4**) and the assessment of the contribution of volatile emissions from ground sources (excavations and remediation of Lednez).

6.3.1 Determination of Chemicals of Potential Concern

The assessment of chronic exposures has been undertaken by comparing the maximum chronic annual average concentration with health based ambient air levels.

Ambient air guidelines have been adopted from a range of sources that consider the toxicity of the chemical (in air) and the period of exposure (averaging time). Annual average concentrations have been utilised (where available). Where the estimated modelled chemical emission exceeds adopted ambient air guidelines, the volatile chemical may be identified as a chemical of potential concern (COPC) that requires further consideration.

The ambient air guidelines adopted for the purpose of screening exposure concentrations are derived from the NEPC Air Toxics Measure (2004), WHO ambient air guidelines and (where guidelines are not available from these sources) inhalation specific reference concentrations available from the USEPA have been adopted. All the ambient air guidelines are protective of inhalation exposures by all members of the population (residents [including sensitive subgroups such as infants, elderly and the infirm] and workers) associated with inhalation exposures every day for a lifetime.

It is therefore considered that this assessment is conservative as the proposed duration of remediation on the Lednez site is considered to be completed within a three year timeframe as the adopted guidelines are protective of exposures in ambient air over a lifetime (i.e. 70years) of exposure.

The following ambient air guidelines have been adopted for the purposes of identifying chemicals of potential concern.

NEPC Air Toxics Measure

In June 1998 (with variations to 2003), the National Environment Protection Council (NEPC) released a National Environment Protection Measure (NEPM) for Ambient Air Quality, setting out national levels for criteria pollutants. This did not include guidelines for Volatile Organic Compounds (VOCs) in ambient air. In April 2004 the NEPC released the Air Toxics NEPM that presented a number of air investigation levels for some key VOCs. The air investigation levels were derived on the basis of the long-term protection of human health within regional areas. The investigation levels are presented on the basis of annual averages (comprised of an average of 24-hour samples), and, for some chemicals, a 24-hour average. The annual average value has been adopted for the purpose of screening.

WHO Air Quality Guidelines

Where individual VOCs detected during the air sampling did not have a guideline from NEPC, the WHO air quality guidelines 2000 and 2000b have been referenced, as well as any recent updates as presented by the World Health Organization (WHO) (Environmental Health Criteria [EHC] or Concise International Chemical Assessment Documents [CICAD] reviews). The WHO Air Quality Guidelines provide guidelines or tolerable concentrations for chemicals on the basis of either (or both) threshold effects and non-threshold carcinogenic effects for a specific averaging time. The selection of the WHO guidelines following those published by the NEPC is in accordance with the NEPM guideline hierarchy. The WHO guidelines adopted for consideration in this assessment reflect annual averages.

Reference Concentrations from USEPA

Where individual VOCs detected during the air sampling did not have a guideline from NEPC or the WHO, reference concentrations (RfCs) available from the USEPA have been used. RfCs are concentrations in air that may be inhaled by all members of the population every day for a lifetime with no adverse effects. They are essentially equivalent to the guidelines and tolerable concentrations available from the WHO and are based on a lifetime of exposure, or an annual average.

The comparison of annual average concentrations to adopted ambient air guidelines is presented in Table 1 **Appendix E**.

6.3.2 Chemicals which Require Additional Assessment

The results of the chronic exposure assessment have indicated that there is one chemical, namely total chromium which exceeds the adopted ambient air criteria and further consideration with respect to long term exposure is warranted. This assessment is detailed further in **Section 6.6.**

6.4 Review of Acute Exposures

Short duration exposures to higher concentrations of chemicals from the modelled stack emissions and ground sources may occur during the remediation of the Lednez site as well as during accidental releases. The assessment of potential acute exposures has been based on the 1 hour maximum from the combined sources (stack and ground sources).

6.4.1 Approach to Acute Assessment

There is a range of different criteria are available for the assessment of potential human health effects associated with short-term emissions to air. No single organisation or methodology has developed acute criteria values or benchmarks for all potential compounds of concern. Hence a hierarchical approach will be utilised for selecting existing guidelines for acute inhalation exposure levels.

Acute inhalation exposure criteria have been developed by a number of organisations which include: American Conference of Governmental Industrial Hygienists (ACGIH); Occupational Safety and Health Administration (OSHA); National Institute of Occupational Safety and Health (NIOSH); American Industrial Hygiene Association (AIHA), National Research Council on Toxicology (NRCT) USEPA; ATSDR, California Environmental Protection Agency (CalEPA); National Advisory Committee (NAC) and the US Department of Energy (DOE); Subcommittee on Consequence Assessment and Protective Actions (SCAPA); and National Occupational Health and Safety Commission (NOHSC).

The acute inhalation exposure criteria have been established by the above organisations and agencies to:

- Be protective of a range of exposure groups including occupational workers, military personnel and the general public;
- Based on a range of exposure durations, typically relevant to the exposure group, but ranging from 15 minutes, to 8 hours (typically for occupational settings) to 24 hours; and
- Protective of a range of toxicological endpoints such as mild discomfort, irritation, serious debilitating and potentially life-threatening effects up to and including death.

The hierarchical approach planned to be used in this assessment is based on that recommended by the USEPA Office of Solid Waste and detailed in the document “Human Health Risk Assessment protocol for Hazardous Waste Combustion Facilities” (Draft, USEPA 1998). The hierarchical approach is focused on the protection of the general public and is summarised below in order of preference:

1) Acute Exposure Guideline Levels (AEGLs) developed by the NAC/AEGL Committee and available from the USEPA;
2) Emergency Response Planning Guidelines (ERPGs) developed by the AIHA and SCAPA;
3) Acute Reference Exposure Levels (ARELs) developed by the CalEPA;
4) Temporary Emergency exposure limits (TEELs) developed by SCAPA; and
5) SCAPA toxicity-based approach as presented by the DOE.

Appendix E of this report presents further detail on each of these guidelines and the relevant basis for the levels proposed by each agency. Acute Exposure criteria are established for the protection of the range of health effects. These range from Level 0 to Level 1 which is protective of all individuals, including sensitive groups, from mild transient effects; Level 2 which is protective of individuals who may be exposed without developing irreversible or serious health effects (injury); Level 3 which is generally the maximum concentration below which individuals will not experience life-threatening effects.

6.4.2 Chemicals which require additional assessment

The assessment of acute exposures indicated that there are no exceedances of the adopted guidelines (refer to **Table 1**, **Appendix F**). Hence there are no chemicals that require further assessment with respect to acute inhalation exposures.

6.5 Quantitative Assessment of Chronic Exposures

The quantitative assessment of potential health risks posed to residents from chronic exposures to total chromium (as identified in **Section 6.3**) is presented below.

6.5.1 Exposure Assessment

As no speciation information is available the assessment of total chromium will be undertaken assuming that 100% of the concentration from stack source (as there is no ground emissions source) is either chromium III or chromium IV.

The assessment also assumes that the concentrations of chromium in indoor air is equal to outdoor air, with different inhalation rates utilised for indoor and outdoor air as outlined in **Table 6-2** below.

Exposure Pathways

The key exposure pathways presented in **Table 6-1** have been identified for the Lot 100 site.

Table 6-1 Summary of Key Exposure Pathways

Receptor	Exposure Pathway	Activity
Residents (Adults, older and younger children)	Inhalation of chromium particulates derived from remediation activities (stack emissions)	Residing on Lot 100
Visitors	Inhalation of chromium particulates derived from remediation activities (stack emissions)	Visiting/Staying on Lot 100

It should be noted that exposures by visitors would be lower than long term residents due to the shorter time spent in the area or at the apartments. Hence a separate evaluation of the potential risks posed to visitors is proposed to not be undertaken.

Exposure Parameters

For the assessment of potential risks via inhalation of particulates to residents (adults, older children and younger children) on Lot 100, the following exposure parameters have been adopted.

Table 6-2 Summary of Exposure Parameters

Receptor Population	Exposure Pathways	Proposed Estimate of Chemical Concentrations	Exposure Parameters
Adult Residents, Older Children, Younger Children	Inhalation of particulates from stack emissions from adjacent Lednez site	Maximum concentrations from dispersion modelling. The Lednez stacks are assumed to have similar emissions as the former Allied Feeds stacks, in the absence of real data.	Inhalation rates indoors: 1.1 m^3/hr (adults), 0.6 m^3/hr (older children), 0.45 m^3/hr (younger children) Inhalation rates outdoors: 2.2 m^3/hr (adults) 1.6 m^3/hr (older children) and 1.25 m^3/hr (younger children).

The assessment of has considered residents to be home all day (24 hours with 20 hours indoors and 4 hours outdoors), every day minus 4 weeks holidays (337 days per year) for a lifetime (i.e. 70 years), even though exposure duration is likely to be for 3 years in duration (as remediation of adjacent site is expected to be completed to 2011), which is conservative.

Quantification of Chemical Intake

When calculating chemical intake or exposure, the risk assessment process focuses on exposure occurring over a prolonged period that is, chronic exposure that occurs over years and possibly a lifetime. Whilst an activity may occur infrequently (i.e. several days a year), it may occur over a long period (i.e. years or decades) and therefore have the potential to increase long term or chronic intake of the chemical. Activities that occur on a once-off basis only have limited potential to make a significant contribution to long term chemical intake. However due to the nature of the remediation activities which includes stack emissions, consideration of acute exposures by residents has also been considered.

The calculation of daily chemical intake requires the estimation of relevant exposure parameters that describe physical and behavioural variables relevant to the exposure evaluated as well as chemical concentrations that are considered relevant to the exposure evaluated.

The assessment presented has addressed potential worst-case exposure to COPC and exposure has been calculated for a ***Reasonable Maximum Exposure (RME)*** scenario estimated by using intake variables and chemical concentrations that define the highest exposure that is reasonably likely to occur in the area assessed. The RME is likely to provide a conservative or overestimate of total exposure and therefore health risk. This approach follows ANZECC/NHMRC guidance (1992) supplemented by USEPA guidance (USEPA, 1989).

The calculation of daily chemical intake will be undertaken using the following equations:

Intakes via Inhalation (particulates)

The assessment of inhalation exposures will be undertaken using the following equation to calculate intake of volatile chemicals via all inhalation pathways:

$$Daily\ Chemical\ Intake_V = C_a \bullet \frac{InhR \bullet ET \bullet DF \bullet CC \bullet FI \bullet EF \bullet ED}{BW \bullet AT} \quad \text{(mg/kg/day)}$$

where:

Ca = Concentration of chemical in air (as relevant for each pathway assessed) (mg/m^3) (Appendix E, Table 1)

InhR = Inhalation rate (dependent on age and activity) (m^3/hr)

ET = Exposure time (dependent on activity) (hr/day)

DF = Deposition Fraction (%) of inhaled dust that will be retained in the respiratory tract

CC =Cilliary Clearance Factor (%) of inspirable dust small enough to reach the pulmonary alveoli (respirable fraction)

FI =Fraction Inhaled from Contaminated Source (1-100%)

EF = Exposure frequency (days/year)

ED = Exposure duration (years)

BW = Body weight (dependent on age) (kg)

AT = Averaging time for threshold and non-threshold exposures (days)

6.5.2 Toxicity Assessment

The assessment of chromium has been undertaken for both a threshold (chromium III) and non-threshold (chromium IV) approach. Detailed in **Table 6-3** below is the adopted toxicity data for exposures via inhalation. Further toxicity information for chromium is provided in **Appendix G**.

Table 6-3 Adopted Toxicity Values

Chemical	Toxicity Value	Reference
Chromium	Inhalation Unit Risk (Cr IV) 0.04 $(\mu g/m^3)^{-1}$	WHO 2000
	TDI (Cr III) 1.5 mg/kg/day equivalent to 0.428 mg/m^3	USEPA Cr (III) current

	Background intake of Cr III = 30%	

6.5.3 Risk Characterisation

Risk characterisation is the final step in a quantitative risk assessment. It involves the incorporation of the exposure assessment and toxicity assessment to provide a quantitative assessment of non-threshold carcinogenic risk and threshold risk. In the assessment presented, evaluation of exposures to the COPC involves an assessment of threshold and non-threshold risks.

The calculation of risks has been undertaken using an in-house spreadsheet model, RiskE (Version 5, URS Australia, 2005). The equations utilised within RiskE follows risk assessment methodology as outlined in **Section 1.5** following protocols established by ANZECC, NHMRC and NEPM. The output from this model has been incorporated into the tables presented and calculation sheets are presented in **Appendix H**.

Hazard Index for Threshold Effects

The potential for adverse threshold effects, resulting from exposure to an individual COPC, has been evaluated by comparing an exposure level, expressed as a daily chemical intake, with the acceptable or tolerable daily intake (ADI/TDI), reference dose (RfD) or TWA. The resulting ratio is referred to by the USEPA as the hazard quotient (USEPA, 1989) and is derived in the following manner:

$$Hazard\ Quotient = \frac{Daily\ Chemical\ Intake}{ADI, TDI, RfD - Background}$$

If the daily chemical intake for the individual COPC exceeds the ADI, TDI, RfD or TWA with consideration of background intakes (where relevant) (i.e. if the hazard quotient exceeds one), then this would indicate potentially unacceptable chemical intakes. The hazard quotient does not represent a statistical probability of an effect occurring.

To assess the overall potential for adverse health effects posed by simultaneous exposure to multiple chemicals, the hazard quotients for each chemical and exposure pathway have been summed. The resulting sum is referred to by the USEPA as the hazard index (HI) (USEPA, 1989). The HI approach assumes that multiple sub-threshold exposures to several chemicals could result in a cumulative adverse health effect, and exposures are summed over all intake routes.

<u>*Acceptable Risk*</u>

An “acceptable” risk in this assessment has been defined as a Hazard Index of 1 (as per risk assessment industry practice, supported by protocols outlined in NEPM [1999] and USEPA guidance).

If the Hazard Index is less than one, cumulative exposure to the site chemicals is judged unlikely to result in an adverse effect. If the index is greater than one, a more detailed and critical evaluation of the risks (including consideration of specific target organs affected and mechanisms of toxic action of the chemicals of concern) would be required to ascertain if the cumulative exposure would in fact be likely to harm exposed individuals.

All hazard quotient and hazard index calculations are presented in **Appendix H**.

Non-Threshold Carcinogenic Risk

The potential for unacceptable non-threshold carcinogenic risks associated with exposure to COPC for residents have been evaluated using US EPA methodology.

Non-threshold carcinogenic risks are estimated as the incremental probability of an individual developing cancer over a lifetime as a result of exposure to a potential non-threshold carcinogen. The numerical estimate of excess lifetime cancer risk is calculated as follows:

Carcinogenic Risk = Daily Chemical Intake x Cancer Slope Factor

The total non-threshold carcinogenic risk is the sum of the risk for each chemical for each pathway.

Australian guidance related to the significance of non-threshold cancer risk estimates is currently not available. However, current USEPA policy states that: *"Where the cumulative site risk to an individual based on reasonable maximum exposure for both current and future land use is less than 10^{-4}, action is generally not warranted unless there are adverse environmental impacts"* (USEPA, 1991). If risks are found to be greater than the 10^{-4} probability, then the USEPA recommends that a preliminary remediation goal of 10^{-6} cancer risk be developed as the point of departure (ibid). URS understands that risks of less than 10^{-5} per lifetime is generally accepted within Victoria as indicating conditions that might warrant specific management or remedial action.

Acceptable Risk

The adopted acceptable risk is defined as a risk of less than 1 x 10^{-5} incremental lifetime risk of cancer.

Summary of Calculated Risk

Detailed in **Table 6-4** is the calculated risks to onsite residents on Lot 100 from inhalation exposures to total chromium as either Cr VI or Cr III.

Table 6-4 Calculated Risks Residents Lot 100

Receptor	Non-Threshold Risk (Cr VI)	Threshold Risk (Cr III)
Adults Lot 100 Indoors	$1.2x10^{-6}$	0.000000008
Adults Lot 100 Outdoors	$2.1x10^{-7}$	0.000000003
Older children Lot 100 Indoors	$9.4x10^{-7}$	0.00000004
Older children Lot 100 Outdoors	$1.0x10^{-7}$	0.000000005
Younger children Lot 100 Indoors	$1.7x10^{-7}$	0.00000002
Younger children Lot 100 Outdoors	$1.1x10^{-7}$	0.00000001
Sum of Lifetime Risk	**$3x10^{-6}$**	**0.00000004**
Target Risks	**$1x10^{-5}$**	**1**

Risk values (including totals) have been rounded to two significant figures and totals rounded to one significant figure; hence the sum of individual risks may not add up exactly to the total presented.

The calculated lifetime risks for exposures to residents (adults, older children and younger children) is below the adopted non-threshold target risk of $1x10^{-5}$ (relevant for assessment of Cr VI) and threshold risk target of 1 (relevant for assessment of Cr III) for exposures to total chromium particulate inhalation on Lot 100. This assessment is considered to be conservative as the lifetime risk calculation is based on 70 year exposure duration when actual exposure duration is likely to be 3 years (i.e. completion of remediation of Lednez by 2011).

6.6 Uncertainty Assessment

In general, the uncertainties and limitations of human health risk assessment can be classified into the following categories:

- Data gaps;
- Sampling and analysis, including groundwater fate and transport modelling;
- Receptor exposure assessment; and

- Toxicological assessment.

The risk assessment process following both ANZECC/NH&MRC and USEPA guidance documents provides a systematic means for organising, analysing and presenting information on the nature and magnitude of risks to public health posed by chemical exposures. Despite the advanced state of the current risk assessment methodology, uncertainties and limitations are inherent in the risk assessment process. This section discusses the uncertainties and limitations associated with this risk assessment.

6.6.1 Data Gaps

There are a number of data gaps within this assessment which are detailed in **Section 2.7** of this report. In general URS have been provided and requested (By DECC) to use available data sets from monitoring assessments conducted at both Allied Feeds and Lednez sites. It is noted that a portion of this data has been provided to URS in electronic format (excel table) with no information regarding the sampling methology, laboratory analysis reports, assessments of accuracy and representativeness of the data set. Therefore an assessment of the suitability of some of the data cannot be undertaken.

6.6.2 Sampling and Analysis

In this assessment, URS have used Summa canister data provided by Thiess from monitoring on the southern boundary of the Lednez site following a request by the DECC. There has been no report generated by the consultant engaged by Thiess to undertake the work which details the justification of sampling location, frequency, analyte selection, data gaps, data analysis and assessment of representativeness and data quality. Therefore URS cannot undertake an assessment of the sampling and analysis quality generated by this data set.

6.6.3 Exposure Assessment

Risk assessments require the adoption of several assumptions in order to assess potential human exposure. This risk assessment includes assumptions about general characteristics and patterns of human exposure relevant to the on-site groups. These assumptions are conservative and developed to provide an estimate of maximum possible exposures rather than the actual exposures. This approach is expected to overestimate the risks. No assessment has been provided for the potential exposure to fugitive emissions associated with surrounding landuses.

6.6.4 Toxicological Assessment

In general, the available scientific information is insufficient to provide a thorough understanding of all of the potential toxic properties of chemicals to which humans may be exposed. It is necessary, therefore, to extrapolate these properties from data obtained under other conditions of exposure and involving experimental laboratory animals.

This may introduce two types of uncertainties into the risk assessment, as follows:

1) Those related to extrapolating from one species to another; and

2) Those related to extrapolating from the high exposure doses, usually used in experimental animal studies, to lower doses usually estimated for human exposure situations.

The majority of the toxicological knowledge of chemicals comes from experiments with laboratory animals, although there may be interspecies differences in chemical absorption, metabolism, excretion and toxic response. There may also be uncertainties concerning the relevance of animal studies using exposure routes that differ from human exposure routes. In addition, the frequent necessity to extrapolate results of short term or subchronic animal studies to humans exposed over a lifetime has inherent uncertainty.

In order to adjust for these uncertainties, ADIs and RfD's incorporate safety factors that may vary from 10 to 1000.

The approach for evaluating risks to mixtures of chemicals assumes dose additively and does not account for potential synergism, antagonism or differences in target organ specificity and mechanism of action. In general, the additively approach has the effect of overestimating the risks. This is because chemicals that have no additive effects are included together as well as chemicals that may have additive effect.

6.6.5 Sensitivity Analysis

The assessment of risk involves the use of models to estimate exposure and in some cases exposure point concentrations. These models require a number of input variables, some of which may be site-specific and others may be derived from other sources of information.

Table 6-5 presents a list of the major input variables used in the risk assessment presented for the calculations undertaken at the site. The table presents the range of practical values for each variable, the value used in the risk assessment, the relative model sensitivity and the uncertainty associated with the variable. This is required to evaluate the sensitivity of the many assumptions used in the quantification of risk.

Table 6-5 Input Variables, Sensitivity and Uncertainty

Input Variable	Practical Range of Values	Value Used in Risk Assessment	Effect on Risk if Variable increased	Relative Model Sensitivity	Relative Uncertainty
Modelled Stack Emissions	Range of concentrations	Maximum stack emission concentration at Lot 100 was adopted in the assessment	Increase	Moderate	Low
Risk Assessment					
Inhalation rate,	Variable, depending on age and activity	Reasonable maximum values selected, concentrations in ambient air were considered to be the same indoors and outdoors, inhalation rates were different for indoor and outdoor air exposures	Increase	Low	Low
Exposure time	3 years (remediation duration of Lednez) to lifetime	Lifetime assessment (i.e. 70 years) adopted in assessment	Increase	Low	Low
Body weight	Variable depending on individual	70 kg (Adult), 34.6 kg (Older child) and 13.2 kg (Younger child)	Decrease	Low	Low

While a number of parameters used within the risk assessment have a moderate degree of uncertainty associated with them and the modelling is sensitive to changes in these parameters, values used to

Section 6 Human Health Risk Assessment

define these parameters have been selected to be conservative. This has resulted in the calculation of risk which is expected to be conservative and an overestimation of actual risk.

Section 7 Conclusions

URS has undertaken a Human Health Risk Assessment (HHRA) for the residential occupation of Lot 100, located within 42 Walker Street, Rhodes (the site). The assessment is limited to the residents on Lot 100 and does not address any offsite receptors surrounding Lot 100. The health risk assessment has focussed on potential exposures from construction activities at the Allied Feeds site during decommissioning and construction of residential developments and the continued remediation on the adjacent Lednez site (due to be completed by mid 2011).

The assessment of potential exposures by residents on Lot 100 has involved the consideration of potential exposures to airborne emissions from a range of sources including volatile materials and particulate matter originating from excavated soil and soil treatment processes occurring on the Lednez site, clean soil trucking movements on the Allied Feeds site and stack emissions from the Lednez DTD and PTB.

The approach to the prediction of ambient air concentrations at Lot 100 involved the development of an air emissions inventory, compilation of meteorological and terrain data, dispersion modelling using CALPUFF and assessment of background air quality data. A range of air pollutants were assessed, however, volatile organic compounds and particulate matter were considered to be air pollutants of primary concern. The combined stack and ground source concentrations for individual analytes were compared to adopted chronic and acute health based screening criteria. Where exceedances were observed, further investigation or a quantitative assessment (health risk assessment) was undertaken.

In addition, a qualitative noise and odour assessment was undertaken where the available investigations were reviewed and conclusions were drawn about the potential exposures for residents on Lot 100.

The approach taken to the quantitative assessment of human health risks was in accordance with guidelines/ protocols provided by enHealth (2004), ANZECC and NH&MRC (as detailed in CSMS 1991, 1993, 1996 and 1998), ANZECC/NH&MRC (1992), NEPM (Schedule B(4), “Guideline on Health Risk Assessment Methodology”, 1999).

Criteria Pollutants (including Particulate Matter)

This assessment of criteria pollutants considered NO_2, PM_{10}, TSP, deposited dust and CO. In accordance with the *Approved Methods* (DEC 2005), the following species require the addition of background concentrations to peak predicted GLCs in order to generate a worst case cumulative concentration: NO_2, PM_{10}, TSP, deposited dust and CO. NO_2 and CO were shown to be within regulatory criteria.

Based on a contemporaneous PM_{10} assessment, the highest cumulative concentration was shown to be present at the south western corner of Lot 100 (Receptor 1) at a concentration of 51.7 µg/m^3, which marginally exceeds the regulatory criteria of 50 µg/m^3. The annual PM_{10} levels, deposited dust levels and peak cumulative TSP levels were, however, below criteria.

The particulate matter assessment is considered conservative, however, elevated concentrations of PM_{10} are likely adjacent to most construction sites where earthworks and large exposed areas are present. To ensure adverse impacts associated with particulate matter are not experienced by residents of Lot 100, it is suggested that dust minimisation procedures are adopted in the Construction Management Plan. This should include regular boundary monitoring to ensure construction operations from the Allied Feeds site and remediation activities from the Lednez site do not result in boundary concentrations of particulate matter in exceedance of regulatory criteria.

Odour

The boundary odour data from the Lednez and Allied Feeds sites were reviewed and it was noted that the majority of odour surveys recorded no detectable odour. Where odour was reported from the Lednez or Allied Feeds sites, community odour complaints were also generally recorded in the Rhodes Community Consultative Committee (RCCC) Meeting Notes.

Section 7 Conclusions

It should, however, be noted that peoples' sensitivities vary, and that the new occupants of Lot 100 may include people with greater sensitivity than current residents or the personnel who have conducted the field odour surveys. .

Given the history of odour complaints during the remediation, in conjunction with the boundary monitoring data, it is expected that odour impacts above the DECC odour criteria (2 odour units) will occur at Lot 100. Continued boundary odour monitoring and the implementation of odour control measures, especially for the excavation of odorous materials, will assist in minimising odour complaints.

Air Toxics

A range of air toxics were considered from stack (based on maximum annual average and acute 1 hour emissions) and area sources (based on data from Summa canister monitoring) were identified at the Lednez site. An assessment of potential chronic and acute exposures by residents at Lot 100 has indicated that the calculated concentrations are below the adopted ambient air criteria (with the exception of chromium) and below acute response levels. The exceedances noted for chromium are from annual average stack emissions from the Lednez site.

The quantitative assessment of potential inhalation exposures associated with chromium emissions (as either Cr VI or Cr III) from the stack (based on lifetime exposures) for residents (adults, older children and younger children) has indicated that the risks to human health are low and acceptable.

Noise

The potential noise impacts of the decommissioning at the Allied Feeds site and construction activities at the Allied Feeds site and the remediation activities at the Lednez site on residents at Lot 100 have been assessed based on the information provided.

A determination of the noise criteria for this assessment is generally based on the following:

- A study of the varying sensitivities of the respective receiver locations; and
- The time duration of the various construction processes.

In establishing the noise criteria for this assessment, it should be noted that highly conservative criteria cannot be applied to a construction site in Sydney Metropolitan area as no construction site would fully comply with the criteria. A building construction site involves a series of complicated processes and activities over a relatively short period of time. Given that the majority of the construction work will occur in the open space, it is practically impossible to reduce noise emissions from these activities to a satisfactory level.

In the past the NSW EPA has waived the conservative blanket criteria for constructions in Sydney area. For example, EPA has agreed to construction noise criteria of 30 dB(A) above background noise level for the M2 Motorway project even though the project involved quiet suburban areas.

This is a similar situation to the construction of Allied Feeds site where high level noise would be generated approximately for 4 weeks. In this assessment, it has been proposed that the project noise criteria be background + 20 dB(A) to 25 dB(A) for residents at Lot 100.

All construction work at the Allied Feeds site is to be carried out in accordance with AS2436-1981 *'Guide to Noise Control on Construction, Maintenance and Demolition Sites'* and the recommendations controlling noise and vibration stipulated in the Meriton's *'Construction Management Plan for Development at 42 Walker Street, Rhodes'*. Whilst construction work is to be carried out according to relevant guidelines, noise levels from the proposed operations during the daytime period are expected to exceed the noise limits occasionally due to the proximity of the receptor location (Lot 100) to the proposed construction activities at Allied Feeds site. It is, however, expected that noise impacts during the night-time period would not exceed the noise limits significantly, and sleep disturbance to residents is therefore not expected to occur.

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Section 9 Limitations

URS Australia Pty Ltd (URS) has prepared this report in accordance with the usual care and thoroughness of the consulting profession for the use of Australian Remediation Services Pty Ltd and only those third parties who have been authorised in writing by URS to rely on the report. It is based on generally accepted practices and standards at the time it was prepared. No other warranty, expressed or implied, is made as to the professional advice included in this report. It is prepared in accordance with the scope of work and for the purpose outlined in the Proposal dated 2nd May 2008.

The methodology adopted and sources of information used by URS are outlined in this report. URS has made no independent verification of this information beyond the agreed scope of works and URS assumes no responsibility for any inaccuracies or omissions. No indications were found during our investigations that information contained in this report as provided to URS was false.

This report was prepared between 2nd May 2008 and 13th February 2008 and is based on the conditions encountered and information reviewed at the time of preparation. URS disclaims responsibility for any changes that may have occurred after this time.

This report should be read in full. No responsibility is accepted for use of any part of this report in any other context or for any other purpose or by third parties. This report does not purport to give legal advice. Legal advice can only be given by qualified legal practitioners.

Figures

Client AUSTRALIAN REMEDIATION SERVICES PTY LTD	Project HUMAN HEALTH RISK ASSESSMENT, OCCUPATION OF LOT 100, 42 WALKER STREET, RHODES	Title SITE LOCALITY PLAN
URS	Drawn: AO · Approved: AL · Date: 11/02/2009 Job No: 43217820 · File No: 43217820.001.wor	Figure: 1

Appendix A Meteorological Data Discussion

Appendix A Meteorological Data Discussion

A.1 Assessment of Meteorological Data 2000-2006

The meteorological data needed for dispersion modelling is required to be site representative. Thiess Services Pty Limited (Thiess) collect meteorological data on site, using an automatic weather station (AWS) and this data was used in this assessment. The AWS is understood to conform to relevant Australian Standards.

The methodology contained in DEC (2005) *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* requires at least several recent years to be assessed to ensure the meteorological data being used is representative. However, the incorporation of ambient air (VOC) monitoring data was necessary for this assessment, and URS was provided ambient air data between September 2007 and November 2008. Consequently, a twelve month period between December 2007 and November 2008 (inclusive) was allocated to be the period where meteorological data was used, which corresponded to ambient air data. For the purposes of this report, it is considered that the meteorological data used in this assessment is representative of normal atmospheric conditions and is referred to as meteorological data for 2008.

A.2 Meteorological modelling

The meteorological data supplied by Thiess included the following parameters:

- Date and time
- Wind speed
- Wind direction
- Temperature

The data was collected hourly averaged and the data availability for the period of assessment (December 2007 through November 2007) was shown to be 97.5% and therefore suitable for further processing.

The meteorology used in the dispersion modelling was generated using local meteorological observations, in conjunction with both the TAPM and CALPUFF modelling systems. The CSIRO's prognostic meteorological model TAPM was used to augment the surface data available from the site AWS. TAPM provided complete upper air and surface station files, in the format required by CALPUFF's meteorological pre-processor CALMET and details on TAPM are further discussed in **Section A.2.1**.

From this point CALMET is able to perform a range of diagnostic calculations which incorporate surface heat flux and terrain effects into the computation of hourly gridded 3-dimensional wind fields.

Utilities exist such that TAPM's output may be exported into CALMET in a gridded (CSUMM) format (developed for the Colorado State University Meteorological Model) for use as an initial guess wind field in CALMET. This is generally performed in order to incorporate synoptic variations across the modelling domain, as output by prognostic models (such as TAPM), prior to the resolution of finer scale meteorology through the diagnostic processes in CALMET.

Given the consistency of wind data in the region, coupled with the complete reliance on TAPM for surface predictions outside of the various radii of influence of the weather stations, this option was not utilised.

A.2.1 TAPM

The Air Pollution Model (TAPM) was utilised to create site specific surface meteorological and upper air files for use in CALMET. TAPM is an incompressible, non-hydrostatic, primitive equation model with a terrain-following vertical co-ordinate for three-dimensional simulations. It includes parameterisations for cloud/rain micro-physical processes, turbulence closure, urban/vegetative canopy and soil, and radiative fluxes. TAPM was specifically required for the creation of upper air files of the area, so that a three dimensional meteorological pattern of the area could be obtained.

TAPM (Version 4), with the use of the input databases provided by CSIRO, was used to generate a meteorological dataset for the year 2008 based on actual synoptic data. To enable TAPM to predict realistic wind profiles, meteorological data measurements on-site (Lednez) was used as an input into the TAPM runs. The following TAPM settings and input files were used to generate the meteorological file. Default options were selected, except where noted below:

- Grid centre coordinates: –33°49'30'' latitude, 151°05'00'' longitude (MGA94: 322625mE, 6255596mN);
- Meteorological grid consisting of five nests of 25 x 25 grid points at 30, 10, 3, 1km and 300m spacing, with 25 vertical grid levels from 10 to 8000 m;
- Terrain at 9 arc-second (approximately 270m) resolution from the Geoscience Australia terrain database. Land characterisation data at approximately 1km resolution, sourced from the US Geological Survey, Earth Resources Observation System (EROS) Data Centre Distributed Active Archive Centre (EDC DAAC). Sea surface temperature data at 100 km grid intervals from the US National Centre for Atmospheric Research (NCAR);
- Six hourly synoptic scale meteorology from the BoM on a 75 to 100 km grid. This data is derived from the BoM LAPS (Limited Area Prediction System) output;
- Customised land use data on the innermost grid; and
- Observation file consisting of measured on-site (Lednez) meteorological data.

A.2.2 CALMET

CALMET is a three dimensional meteorological simulation package included within the CALPUFF suite of programs. CALMET predicts three dimensional wind profiles and atmospheric parameters for use in predicting dispersion conditions through CALPUFF. Surface and upper air files generated by TAPM were used in predicting wind profiles over the modelling domain with CALMET.

- Grid Origin: 319450mE, 6252450mN (MGA94) with 61 x 61 grid cells at 100 m resolution (Total grid dimension of 6.1 km x 6.1 km) using digitized terrain and land use data;
- 12 vertical levels with cell faces at 0, 20, 40, 60, 80, 100, 140, 180, 260, 400, 500, 1500 and 3000m;
- TAPM generated surface and upper air meteorological stations for a point located at the centre of the area being considered;
- 3 km radius of influence for surface and and 5 km radius of influence for upper air data for step 2 objective analysis wind fields;
- 1 km radius of influence for terrain effects;

Figure A1 depicts the CALMET modelled domain, overlaid with specific land uses (urban and water) as input into the CALMET model.

A.2.3 Windroses

The annual and seasonal windroses for the CALMET / TAPM generated meteorological data are provided in **Figure A2**. These wind roses show dominance of winds from the southwest over the year and for the seasons of autumn and winter. Summer shows a high degree of north and south easterlies, while spring shows the presence of a more uniform spread of wind directions.

Appendix A Meteorological Data Discussion

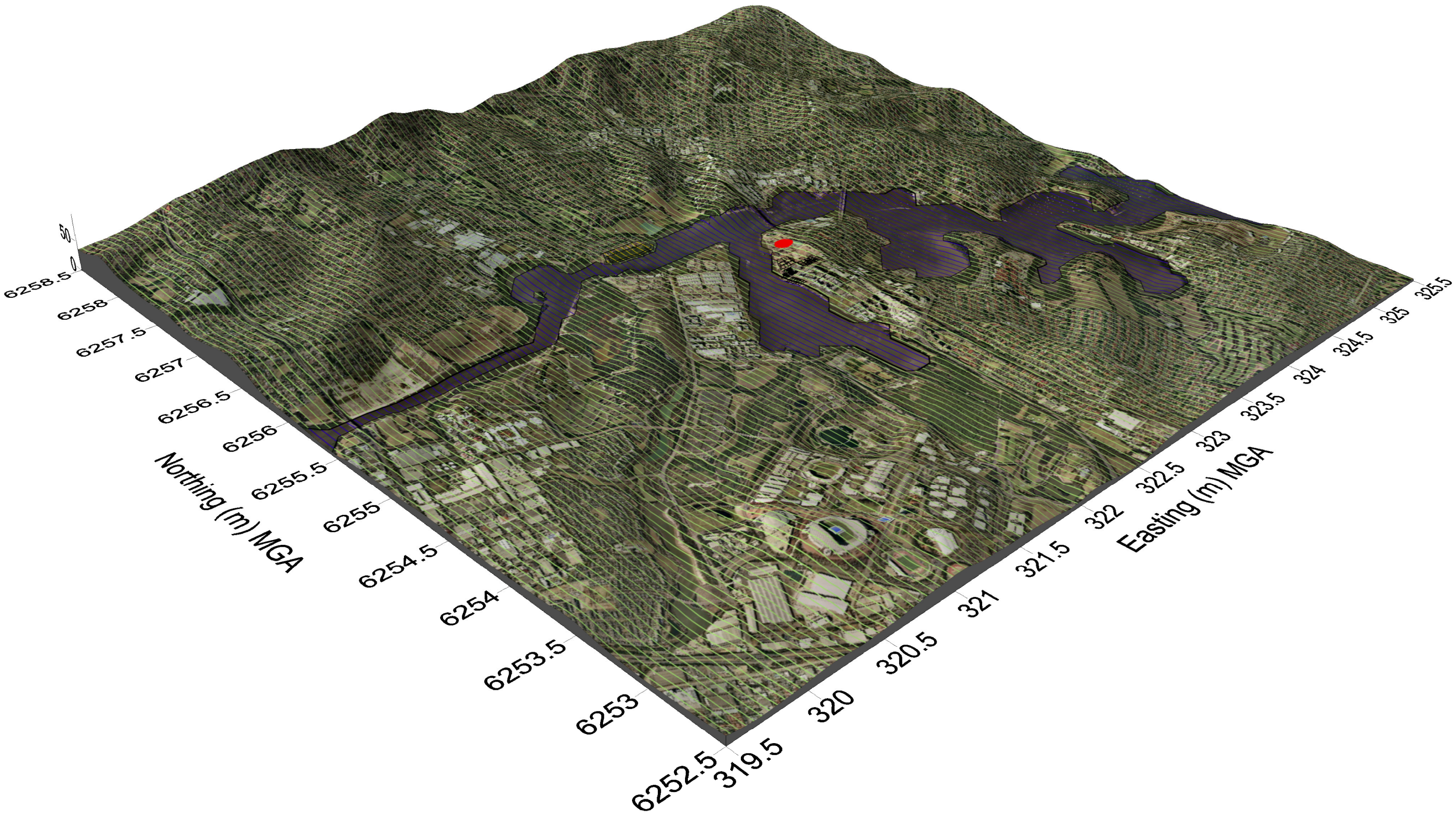

Figure A1: Land Use Configuration Overlaid on Aerial Photo for CALMET Modelled Domain

Appendix A Meteorological Data Discussion

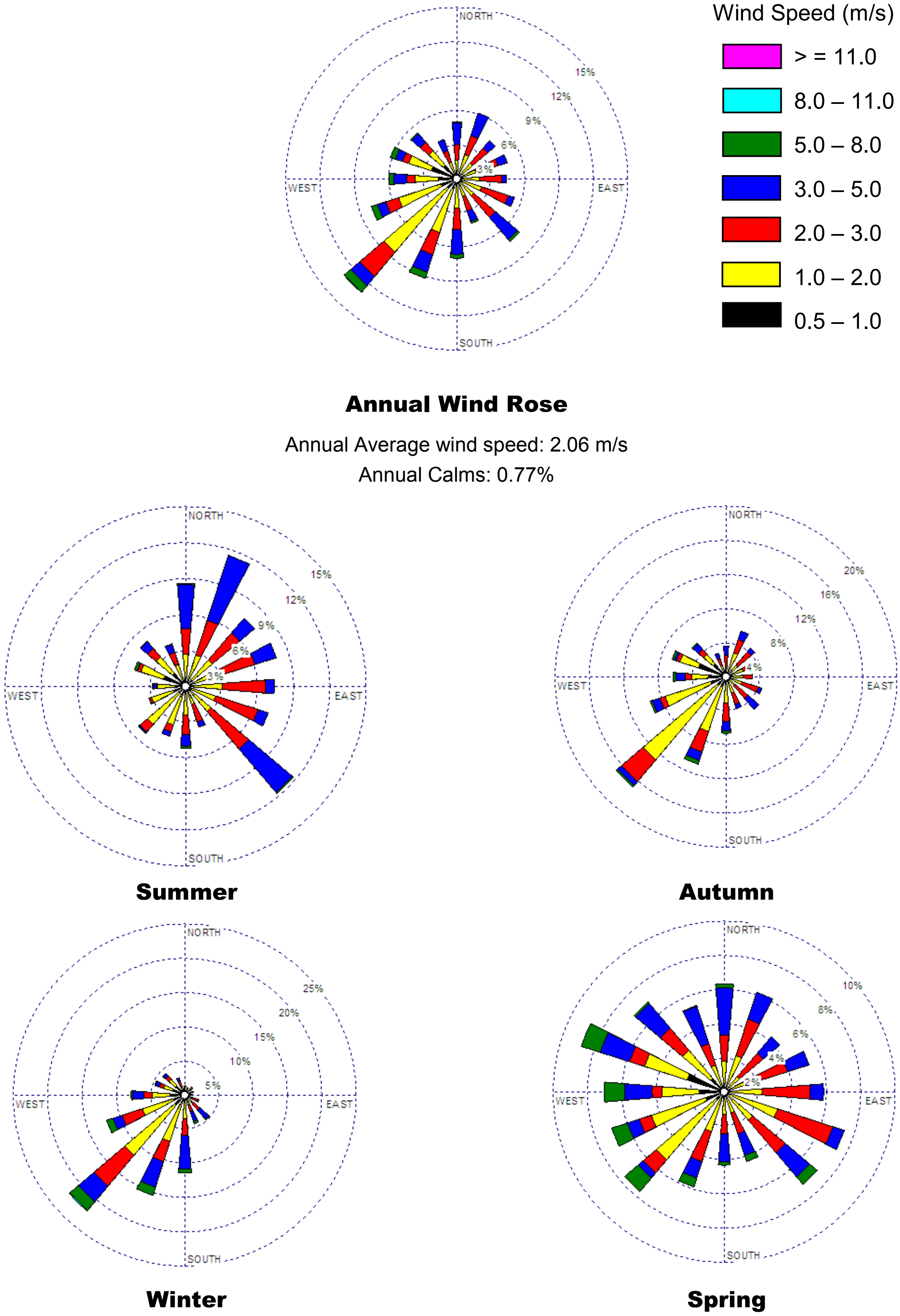

Figure A2: Seasonal CALMET / TAPM generated wind roses for Site (December 2007 - November 2008)

Appendix A Meteorological Data Discussion

The following sections discuss the atmospheric parameters for the proposed development site, as generated by CALMET/TAPM for 2008.

A.3 Mixing Height

Figure A3 shows the Mixing Height (m) vs Time of Day (Hour) for 2008. The figure shows that the predicted mixing height increases with increasing solar radiation as a function of time of day. This is consistent with general atmospheric processes that show increased vertical mixing during the daytime associated with the increasing thermal radiation. Night time conditions are cooler, more stable and, as expected, winds are generally lighter thus vertical mixing is reduced leading to a lower mixing height.

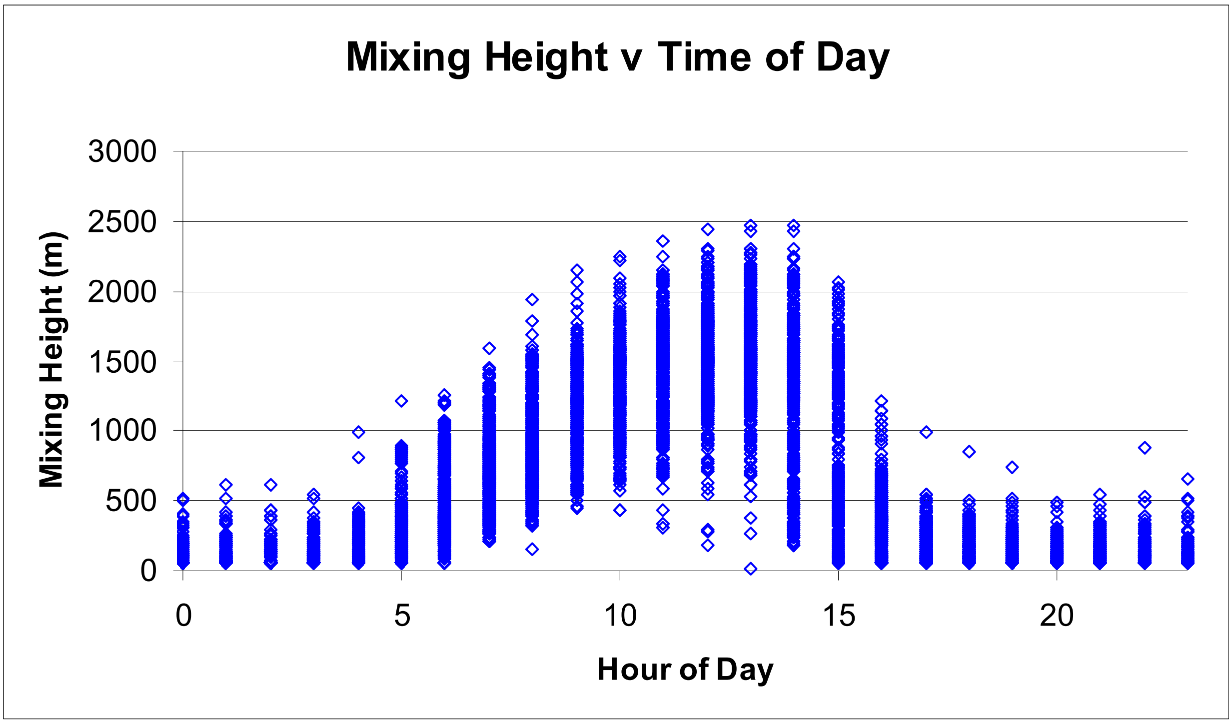

Figure A3: Mixing Height (m) vs Time of Day (Hour of Day) - generated by CALMET/TAPM for the Lednez / Allied Feeds Site 2008

A.4 Atmospheric Stability

Stability class is used as an indicator of atmospheric turbulence for use in meteorological models. The class of atmospheric stability generally used in these types of assessments is based on the Pasquill-Gifford-Turner scheme where six categories are used (A to F) which represent atmospheric stability from extremely unstable to moderately stable conditions. The stability class of the atmosphere is based on three main characteristics, these being:

- Static stability (vertical temperature profile/structure);
- Convective turbulence (caused by radiative heating of the ground); and
- Mechanical turbulence (caused by surface roughness).

The Pasquill Gifford Stability classes are provided in **Table A1**.

The stability classes for the site have been extracted from the CALMET/TAPM generated meteorological file and are shown in **Table A2**.

Appendix A Meteorological Data Discussion

Table A1: Modified Pasquill-Gifford Stability Classes (adapted from Turner, 1994[1])

Surface Wind Speed at 10m (m/s)	Insolation			Night-time cloud (Oktas)	
	Strong	Moderate	Slight	Thinly overcast of > 4/8 low cloud	< 3/8 Cloud
≤ 2	A	A-B	B	-	-
2 - 3	A-B	B	C	E	F
3 - 5	B	B-C	C	D	E
5 - 6	C	C-D	D	D	D
> 6	C	D	D	D	D

Notes:
- : Generally referred to as strongly stable conditions.

The Pasquill Gifford Stability Classes, shown in **Table A2** shows moderately stable atmospheric conditions (Stability Class D) is the most prevalent Stability Class of the area, with the Extremely Unstable conditions (Stability Class A) being the least prevalent.

Table A2: Site Representative Pasquill-Gifford Stability Classes

Stability Class	% of year
A (Extremely Unstable)	4.7
B (Moderately Unstable)	18.0
C (Slightly Unstable)	17.0
D (neutral)	12.1
E (Slightly Stable)	5.4
F (Moderately Stable)	42.8

1 Turner B 1994 *Workbook of Atmospheric Dispersion Estimates: An Introduction to Dispersion Modelling*. 2nd Edition. CRC Press Inc

Appendix A Meteorological Data Discussion

In addition to their composition, Stability Classes were also analysed as a function of time of day, as shown in **Figure A4**. The Stability Classes in **Figure A4** are labelled 1 through 6 and refer to Stability Classes A (Extremely Unstable) through F (Very Stable) respectively. As expected, the Stability Classes show a tendency for the unstable classes (Stability Classes A, B and C) to occur during daytime, whilst the more stable conditions (Stability Classes D, E and F) are shown to occur primarily during night time. This is consistent with the values contained in **Table A2**.

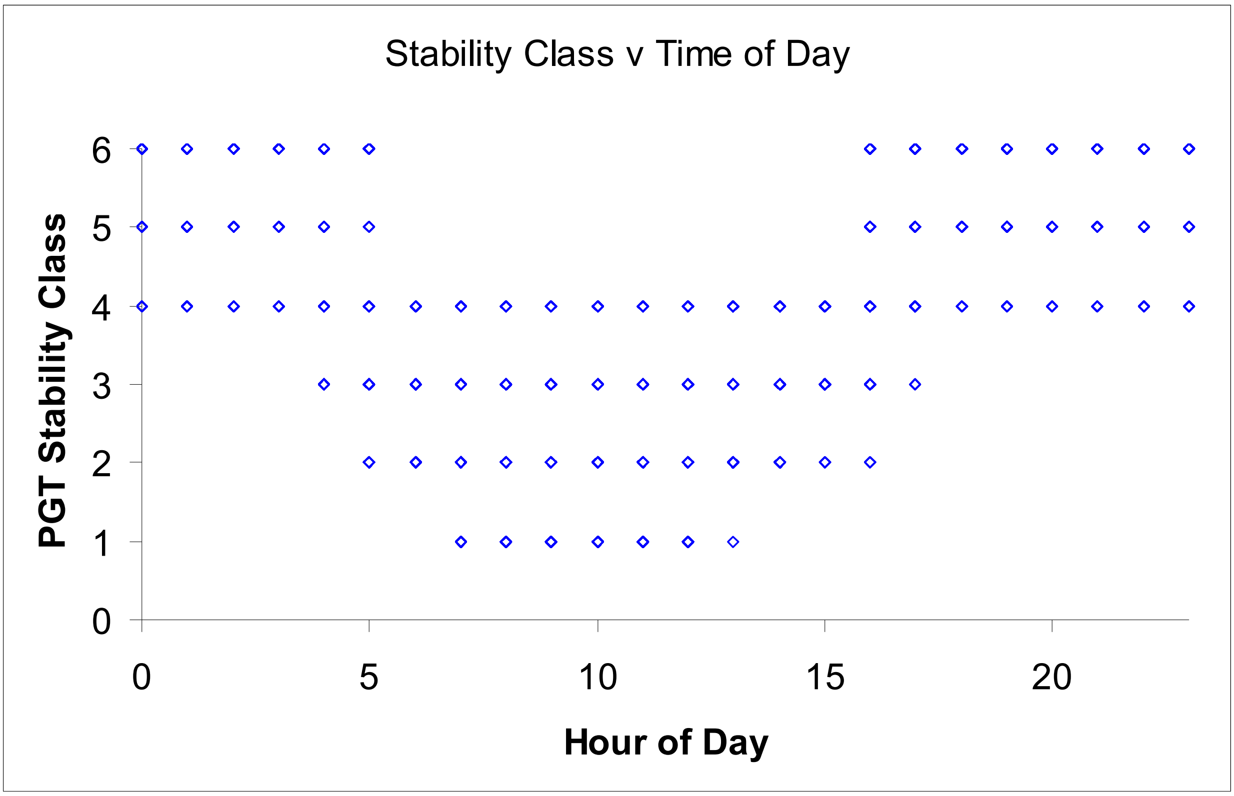

Figure A4: Stability Class vs Time of Day - generated by CALMET / TAPM predicted for Lednez / Allied Feeds Sites 2008

Appendix A Meteorological Data Discussion

Stability Classes were also measured against wind speed, as shown in **Figure A5**. The Stability Classes in **Figure A5** are labelled 1 through 6 and refer to Stability Classes A through F respectively. As expected, the highest wind speeds are associated with stable or neutral stability classes (Stability Classes C and D). The more unstable conditions (Stability Classes A and B) have lower wind speeds due to vertical mixing, and the more stable conditions (Stability Classes E and F) also have low wind speeds as a result of stable night time atmospheric conditions. These data are consistent with the values contained in **Table A2.**

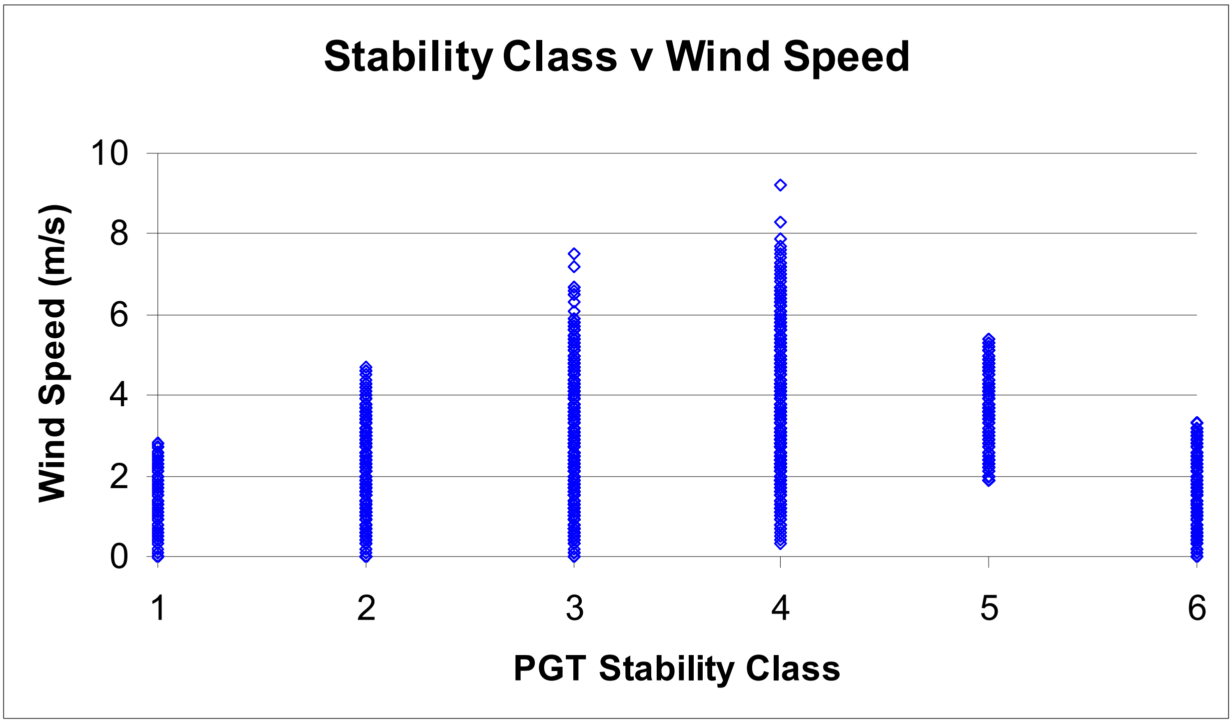

Figure A5: Stability Class vs Wind Speed - generated by CALMET / TAPM for Lednez / Allied Feeds Sites 2008

A.5 Conclusion

Site specific meteorological data, collected using an AWS between December 2007 and November 2008, has been prepared for dispersion modelling. The data were further processed using TAPM and CALMET, which are sophisticated, 3D meteorological models that have been extensively validated.

The assessment of the predicted meteorology at the Lednez / Allied Feeds site was discussed and was shown to be consistent with general atmospheric parameters. It is therefore considered that the meteorological data used in dispersion modelling is appropriate.

Appendix B Particulate Matter Assessment

B. Particulate Matter Assessment

Appendix B Particulate Matter Assessment for Residential occupation of Lot 100

B.1 Introduction

A particulate matter (dust) assessment has been performed in order to consider the potential impact of dust emissions from activities occurring on the Allied Feeds and Lednez sites during the proposed residential occupation of Lot 100.

The ambient air concentrations of particulate matter have been assessed through dispersion modelling based on an inventory of activities occurring on the Lednez Site, along with an inventory of construction works occurring on the Allied Feeds Site. Emission rates have been estimated through the emission factors adopted in *National Pollutant Inventory – Emission Estimation Technique Manual for Mining* (V2.3, December 2001), and *US EPA AP42 - Compilation of Air Pollutant Emission Factors* (Fifth Edition Volume I).

Particulate matter (dust) is generally divided into two broad fractions, deposited and suspended. Deposited particulate matter is dust that, because of its aerodynamic diameter and density, rapidly falls from the air. In general terms, deposited particulate has a diameter of greater than about 20 µm. However there is no distinct dividing line between these particles and the smaller particles of suspended matter that fall less readily or slowly out of the air. Because of the size of the particulate matter, most of this material will not enter the body. Hence the effects of deposited particulate are primarily considered a nuisance and are unlikely to represent a health risk.

Suspended particulate matter is dust or aerosol that stays suspended in the atmosphere for significant periods. The current nomenclature is to describe fractions of suspended particulate as:

- PM_{10}: all particulate effectively less than 10 microns (µm) in diameter; and
- TSP: Total Suspended Particulate, generally less than 50 µm in diameter.

1.1.1 Assessment Criteria

The Department of Environment and Climate Change (DECC), incorporating the New South Wales Environment Protection Authority (EPA) have published impact assessment criteria to be applied in the design stages of an activity to ensure that there will be no adverse impact on public health or amenity values[1]. These applicable impact assessment criteria associated with particulate matter is summarised in **Table B1** below.

Table B1: Particulate Matter Assessment Criteria

Pollutant	NSW EPA Impact Assessment Criteria (µg/m^3)[a]	Averaging Time
PM_{10}	50	24 hours
	30	Annual
TSP	90	Annual
Deposited Dust	2 g/m^2/month[b]	Annual
	4 g/m^2/month[c]	Annual

Notes: [a] Criteria in µg/m^3 unless otherwise stated. [b] Maximum increase in deposited dust level. [c] Maximum total deposited dust level.

[1] DEC, (2005) *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales*, Department of Environment and Conservation.

Appendix B

Particulate Matter Assessment for Residential occupation of Lot 100

B.2 Methodology

B.2.1 Atmospheric Dispersion Modelling

This section provides a description of the modelling methodology utilised for predicting particulate matter impacts at Lot 100. The modelling methodology involved the use of the TAPM, CALMET and CALPUFF computer modelling packages. A description of each model and the input parameters used is provided in the subsequent headings.

Dispersion Meteorology

The computer modelling programs TAPM and CALMET have been used to compile a three dimensional meteorological model of the Rhodes peninsula. This modelling also incorporated wind information from the automatic weather station located on the Lednez Site. Modelled wind flow regimes were directly used for establishing predicted pollutant concentrations at Lot 100. Details regarding the models and the parameters used can be found in **Appendix A**. The meteorological models are also consistent with those utilised within the Stack Analysis Assessment (**Appendix C**).

Receptor Locations

Ambient concentrations were predicted at a total of 20 locations across Lot 100. For each of the 20 discrete receptor locations shown in **Figure B1**, model predictions were calculated at ground level, as well as 7m, 14m, 21m, and 28m elevation. This was performed in order to estimate concentrations across the vertical extent of the proposed construction operations.

CALPUFF

The US EPA and NSW EPA approved modelling package CALPUFF has been utilised for predicting local particulate matter impacts at Lot 100. CALPUFF is a non-steady-state Gaussian puff dispersion model. The CALPUFF program is able to account for spatial variability of meteorological conditions, causality effects, low wind speed dispersion (during ‘calm’ conditions), and dispersion effects over a variety of spatially varying land surface. The dispersion modelling conducted in CALPUFF utilised the following parameters:

- A single “puff” modelling scenario considered spanning a single calendar year (December 2007 to November 2008 inclusive);
- No chemical transformation, with dry particle phase deposition effects considered;
- ISC Urban wind speed profile exponents considered;
- Dispersion coefficients using turbulence-based micro-meteorology;
- Partial plume path adjustment utilised for considering terrain effects;
- Dust sources were represented as volume sources; and
- Source emission rates and options as discussed within the emission inventory and throughout this report.

B.2.2 Emissions Inventory

Operating Hours

Based on information provided by Thiess and Meriton (O'Hanlon, Pers.Comm. 2009)[2], (Levy, Pers.Comm. 2009)[3], during the week, typical[4] operating hours on the site are:

- Meriton / Allied Feeds: 7am – 3:30pm; and
- Thiess / Lednez: 7am – 5pm.

The following representation of operating hours has been incorporated into the dispersion model:

- Meriton / Allied Feeds: 7am – 4pm, every day of the modelling period; and
- Thiess / Lednez: 7am – 5pm, every day of the modelling period.

Emissions from the Lednez soil treatment facility, as well as wind erosion have been assumed to occur during all hours of the modelling period.

Site Activities

A number of operational and construction activities have been included in predicting particulate matter emissions. As a result of remediation activities having been completed on the Allied Feeds site, the following construction and material handling emissions have been assessed:

- Excavation operations on lots 101 and 102 for associated apartment basement installations. (It is understood that these operations may not take place over the next 6 to 12 months, however the emissions associated with this activity have been incorporated into the model to occur simultaneously);
- Unpaved roadway emissions from truck movements delivering materials associated with the construction of apartments on lot 103; and
- Wind erosion of stockpile and exposed areas.

Lednez remediation activities will continue to occur and thus the following operational activities have been assumed to be occurring. These activities include:

- Operation of a single excavator to remove material from the remediation area;
- Operation of a single excavator to load backfill material into Homebush Bay;
- Operation of a single excavator to empty storage trenches and load treated material;
- Unpaved roadway emissions from truck movements delivering Virgin Excavated Natural Material (VENM) shale backfill to the bay load out point;
- Unpaved roadway emissions from truck movement delivering material to the Pre-Treatment Building (PTB);
- Unpaved roadway emissions from truck movements delivering treated material to final backfill location;

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[2] O'Hanlon, D. 2009 – Personal Communication with B. Levy of Meriton Apartments P/L

[3] Levy, B. 2009 – Personal Communication with D.O'Hanlon of Thiess Services P/L

[4] During exceptional events work may continue on the Lednez Site beyond 5pm.

- Unpaved roadway emissions from truck movements to and from temporary storage cell;
- Loading of VENM shale to trucks at the VENM shale stockpile;
- Unloading of material to be treated at the PTB;
- Unloading of treated material at final backfill location;
- Two front-end loaders operating within the cell;
- Wind erosion of DTD treated material stockpile, and VENM shale stockpile; and
- Particulate Emissions (PM_{10}) associated with DTD stack operation.

The following emission sources have been omitted from the assessment:

- Unloading of dredged material from barge (assumed too high in moisture content to emit dust).

An emissions inventory of the modelled particulate matter sources is provided in **Table B2** and **Table B3** for the Lednez and Allied Feed site activities respectively. A more detailed emissions inventory is provided as **Attachment B2** at the end of this appendix. **Figure B1** provides an aerial photo detailing source and receptor locations considered in the modelling stage of the particulate matter assessment. It should be noted that source locations have been approximated and may differ from actual locations, given the constantly changing nature of the sites. Details regarding the equations and emissions factors adopted for the site emissions inventory are provided in the following sections.

Appendix B

Particulate Matter Assessment for Residential occupation of Lot 100

The locations of these sources are shown on **Figure B1** below.

Figure B1: Aerial Photograph Showing Source and Receptor Locations Considered

Appendix B

Particulate Matter Assessment for Residential occupation of Lot 100

Table B2: Emission Inventory for Lednez Site

Summated Particulate Matter Emission Inventory (Lednez)				
Source Name	**Source ID**	**Throughput Volumes**	**PM_{10} Emission Rate (kg/hr)***	**TSP Emission Rate (kg/hr)**
Soil Removal / Excavation Activities				
Excavator operating in remediation area	EX3	1625 t/day	0.029	0.061
Excavator loading backfill material into the bay	EX4	1250 t/day	0.022	0.047
Excavator emptying storage trenches and loading DTD treated material	EX5	2750 t/day	0.049	0.103
Truck Haulage (Assuming Haul Road Watering with 90% Emission Reduction)				
Roadway emissions from trucks delivering clean VENM shale backfill to bay load out area	HRS3	6.31 VKT	0.032	0.130
	HRM3	6.31 VKT	0.032	0.130
	HRE3	6.31 VKT	0.032	0.130
Roadway emissions from trucks delivering material to the PTB	HRS4	2.2 VKT	0.011	0.045
	HRM4	2.2 VKT	0.011	0.045
	HRE4	2.2 VKT	0.011	0.045
Roadway emissions from trucks delivering treated material to final backfill location	HRS5	13.44 VKT	0.068	0.276
	HRM5	13.44 VKT	0.068	0.276
	HRE5	13.44 VKT	0.068	0.276
Roadway emissions from trucks to and from temporary storage cell	HRS6	2.52 VKT	0.013	0.052
	HRM6	2.52 VKT	0.013	0.052
	HRE6	2.52 VKT	0.013	0.052
Unloading / Loading Operations				
Transfer of Shale to trucks	TR1	1250 t/day	0.022	0.047
Unloading material at PTB	TR2	1250 t/day	0.022	0.047
Unloading treated material at backfill area	TR3	1250 t/day	0.022	0.047
FEL operating in Cell	TR4	1250 t/day	0.022	0.047
FEL operating in Cell	TR5	1250 t/day	0.022	0.047
Wind Erosion				
DTD treated material stockpile	SP1	2080 m^2	0.042	0.083
VENM shale stockpile	SP2	2705 m^2	0.054	0.108
Stacks				
DTD Stack	LDTD	-	0.18 g/s	-
PTB Stack	LPTB	-	0.031 g/s	-

Notes: * Emission rates are in kg/hr unless otherwise stated. All emissions from the DTD and PTB stacks have been assumed to be PM_{10}.

Appendix B

Particulate Matter Assessment for Residential occupation of Lot 100

Table B3: Emission Inventory for Allied Feeds Site

Summated Particulate Matter Emission Inventory (Allied Feeds)				
Source Name	**Source ID**	**Throughput Volumes**	**PM_{10} Emission Rate (kg/hr)**	**TSP Emission Rate (kg/hr)**
Soil Removal / Excavation Activities				
Excavation of Lot 101	EX1	675 t/day	0.0133	0.0282
Excavation of Lot 102	EX2	675 t/day	0.0133	0.0282
Truck Haulage (Assuming Haul Road Watering with 90% Emission Reduction)				
Roadway emissions from trucks removing excavated materials from lots 101 and 102	HR1a	1.3 VKT	0.0073	0.030
	HR1b	1.3 VKT	0.0073	0.030
	HR1c	1.3 VKT	0.0073	0.030
	HR1d	1.3 VKT	0.0073	0.030
	HR1e	1.3 VKT	0.0073	0.030
	HR1f	1.3 VKT	0.0073	0.030
	HR1g	1.3 VKT	0.0022	0.009
	HR1h	1.3 VKT	0.0022	0.009
	HR1i	1.3 VKT	0.0022	0.009
	HR1j	0.4 VKT	0.0022	0.009
	HR1k	0.4 VKT	0.0022	0.009
	HR1l	0.4 VKT	0.0022	0.009
	HR1m	0.4 VKT	0.0022	0.009
	HR1n	0.4 VKT	0.0051	0.020
	HR1o	0.4 VKT	0.0051	0.020
	HR1p	0.4 VKT	0.0051	0.020
Roadway emissions from trucks delivering materials to lot 103 (under construction)	HR2a	0.9 VKT	0.0051	0.020
	HR2b	0.9 VKT	0.0101	0.041
	HR2c	0.9 VKT	0.0101	0.041
	HR2d	0.9 VKT	0.0073	0.030
	HR2e	1.8 VKT	0.0073	0.030
	HR2f	1.8 VKT	0.0073	0.030
Wind Erosion				
Wind erosion exposed areas	EA1	625 m^2	0.013	0.025

Appendix B

Particulate Matter Assessment for Residential occupation of Lot 100

Excavation Activities

Emission factors associated with excavation activities have been determined by Equation 1, adopted from *National Pollutant Inventory – Emission Estimation Technique Manual for Mining* (V2.3, December 2001).

$$EF = k \times 0.0016 \times \left(\frac{U}{2.2}\right)^{1.3} \times \left(\frac{M}{2}\right)^{-1.4}$$ Equation 1

Where: k = 0.74 for TSP emissions, 0.35 for PM_{10} emissions

U = Wind speed (m/s) = 2.44 m/s (average wind speed from observed on site for 2008)

M = moisture content, assumed to be 5 %

Substituting the relevant equation parameters provides a PM_{10} emission factor of 0.00018 kg/t and a TSP emission factor of 0.00038 kg/t of material excavated.

Approximately 97,000 tonnes would be excavated from lots 101 and 102 (sources EX1 and EX2), with 45 truck movements per day (approximately 30 tonne capacity). This equates to approximately 1350 t/day or 675 t/day for each excavator respectively.

Approximately 300-1000 m^3 of in-situ characterized material would be excavated from the Lednez site per day (source EX3). Assuming an average of 650 m^3 is removed daily, with density of 2500 kg/m^3 based on truck volumes and tonnages, a total of 1625 t/day is excavated.

Approximately 500 m^3 of VENM shale would be transferred to the bay loading point for backfilling by excavator to barges (source EX4). Assuming a density of 2500 kg/m^3, a total of 1250 t/day is transferred.

Approximately 600 m^3 of dredged material would be transferred from the storage trenches per day. Assuming that this material has a density of 2500 kg/m^3, a total of 1500 t/day is transferred by excavator (source EX5) which has the potential for dust emissions if the material has been allowed sufficient time to dry. This excavator is also used for transferring DTD treated material at a rate of 1250 t/day, thus a total material transfer load of 2750 t/day is apparent for this source. These activities were assumed to have no dust controls.

Truck Haulage

Emission factors associated with unpaved roadway emissions from truck movements have been determined by Equation 2, adopted from USEPA AP-42 (Section 13.2.2 *Unpaved Roads*, 2006)

$$EF = k \times \left(\frac{s}{12}\right)^{a} \times \left(\frac{w}{2.722}\right)^{b}$$ Equation 2

Where: k = 0.423 for PM_{10}, and 1.381 for TSP

s = silt content of road material (%) = 4

w = vehicle gross mass = 25 t (empty) and 50 t (full)

a = 0.9 for PM_{10} and 0.7 for TSP

b = 0.45

Substituting the relevant equation parameters, and taking the average of the emission factors for full and empty trucks provides a PM_{10} emission factor of 0.05 kg/VKT and a TSP emission factor of 0.21 kg/VKT. This accounts for vehicle weights on both the delivery and return trips.

Emission rates for each haul road have been determined by the number of truck movements and calculated kilometres travelled along each haul road. Each haul road on the Allied Feeds Site has been represented in the dispersion model as volume sources located at either 10 m or 20 m separation along the road. Each haul road on the Lednez Site has been represented in the dispersion model as three separate volume sources located at equidistant locations along the road. Details regarding truck movements, vehicle kilometres travelled and subsequent emission factors can be seen in the emission inventory located as **Attachment B2**. A haul road watering control factor of 90% has been applied to determined roadway emissions, to account for the reduction in dust emissions from regular watering activities, and higher soil moisture contents.

Unloading / Loading Operations

Emission factors associated with material transfer, unloading and loading operations along with FEL operations have been determined from Equation 1. Equation 1 is also applicable for miscellaneous transfer points and FEL operations. A PM_{10} emission factor of 0.00018 kg/t and a TSP emission factor of 0.00038 kg/t have therefore been adopted.

A daily transfer volume of 1250 t/day has been applied to unloading, loading and other miscellaneous transfer activities, based on transfer volumes considered during excavation activities. No controls have been assumed for this dust source.

Wind Erosion

Emission factors associated with wind erosion of stockpiles and exposed areas have been adopted from *National Pollutant Inventory – Emission Estimation Technique Manual for Mining* (V2.3, December, 2001). Emission factors adopted are as follows:

0.4 kg/ha/hr for TSP

0.2 kg/ha/hr for PM_{10}

A 25 m by 25 m (625 m^2) exposed area has been assumed for the Allied Feeds facility. This has been located at lot 104 which is expected to be less compacted and more exposed then other areas of the site. An emission rate of 0.025 kg/hr (TSP) and 0.0125 (PM_{10}) is applied given this assumption.

Areas of 2080 m^2 and a 2705 m^2 area have been assumed for the DTD treated material and VENM shale backfill stockpiles respectively, both of which are located on the Lednez site. This has been based on supplied maps and aerial photos.

Lednez Stack Sources

The Lednez DTD and PTB stacks will be operational during the period of proposed occupation. Particulate matter associated with the stacks operation is considered to in the PM_{10} size fraction. The maximum particulate matter emission rates of 0.18 g/s and 0.032 g/s (for the DTD and PTB respectively) have been referenced from stack reports provided by Thiess[5] and applied as a constant value.

B.2.3 Background Monitoring

Particulate matter monitoring conducted at Blaxland Road during the assessment period has been incorporated for the purposes of assessing cumulative impacts of PM_{10}, over a 24 hour averaging period. Thiess monitor PM_{10} levels continuously at two sites using Tapered Element Oscillating Microbalance analysers (TEOM), fitted with inlets which are sized to measure PM_{10}. The two sites are located at Blaxland Road (to the east of the Lednez site), and Gauthorpe St (immediately to the south of the Lednez Site). This assessment has primarily used the Blaxland Road monitoring data, with inclusion of the Gauthorpe St data where exceedances were found to occur with the use of Blaxland Rd data. This

[5] URS (2008), '*Human Health Risk Assessment for Onsite Construction Workers, Lot 103, Former Allied Feeds Site, Rhodes*'

approach has been adopted in order to use monitoring data which has had the lowest influence from activities on the Allied Feeds and Lednez sites. **Attachment B1** provides graphical representations of the 24 hour PM_{10} monitor results. Reference should also be made to **Figure 1** of the main report, for the location of the Blaxland particulate matter monitor.

Ideally, the monitoring data would be sourced from a location that has not been influenced by dust generating activities that have been considered in the dispersion modelling. However, it is noted that contemporaneous PM_{10} monitoring data from the nearby Rozelle DECC monitoring station is not available at the time of reporting. Hence whilst the Blaxland Road monitoring data has been slightly compromised by nearby emissions, its incorporation is considered conservative.

Appendix B

Particulate Matter Assessment for Residential occupation of Lot 100

B.3 Dispersion Modelling Results

Summary

Table B4 provides a summary of the peak results of the dispersion modelling for PM_{10}, TSP and deposited particulate. Considering these incremental impacts alone, no exceedance of relevant particulate matter criteria was predicted. A cumulative impact of PM_{10} 24 hour average concentrations is provided.

Table B4: Peak Particulate Matter Concentrations at All Receptors on Lot 100

Quantity	PM_{10}		TSP	Deposited Dust
	24 Hour	Annual	Annual	Annual Averaged Monthly Deposition
	(μg/m³)	(μg/m³)	(μg/m³)	(g/m²/month)
Model Prediction	17.2 (5.9)	6.1	18.9	0.89
Background Concentration	23.4 (45.8)	17.6*	35.2**	NA
Cumulative Concentration	40.6 (51.7)	23.7	54.1	0.89
Regulatory Criteria	**50**	**30**	**90**	**2**

Notes: *Value calculated from Blaxland Road monitoring data.
**In the absence of TSP monitoring data, value has been assumed to be double that of PM_{10}.
Shaded cells indicate values above criteria. Values in brackets detail single additional exceedance. For more detail see the following section which includes a contemporaneous assessment.

Contemporaneous Analysis of Cumulative PM_{10} Concentrations

Tables B5, B6 and B7 show contemporaneous PM10 concentrations sorted in descending order by model prediction, background concentration, and cumulative total (respectively).

For the 366 days modelled, the cumulative results show one additional exceedance. On this day, a background concentration of 45.8 μg/m³ was reported at Blaxland Road, with a contemporaneous predicted impact of 5.9 μg/m³ at Lot 100. As a result, the criterion of 50 μg/m³ was exceeded by 1.7 μg/m³. Given the minor contribution of the model prediction, and the likely double counting of emissions from Lednez and Allied Feeds sites, this exceedance is not considered significant.

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Particulate Matter Assessment for Residential occupation of Lot 100

Table B5 - Peak PM_{10} 24 hour Impacts Sorted by Order of Decreasing Model Predictions

24 hour PM_{10} Concentrations (µg/m³)				
Rank	**Date (YYMMDD)**	**Background**	**Model Prediction**	**Cumulative Total**
1	080703	23.4	**17.2**	40.6
2	080612	19.3	**16.6**	35.9
3	080804	22.1	**16.5**	38.6
4	080525	30.6	**15.8**	46.4
5	080520	22.5	**15.3**	37.8
6	080528	21.3	**15.3**	36.6
7	080716	21.1	**15.2**	36.3
8	080623	21.9	**15.1**	37.0
9	080727	11.5	**15.0**	26.5
10	080529	20.2	**14.9**	35.1
11	080524	24.6	**14.8**	39.4
12	080531	14.4	**14.6**	29.0
13	080706	18.2	**14.5**	32.7
14	080527	28.1	**14.5**	42.6
15	080625	22	**14.1**	36.1
16	080715	27.3	**14.1**	41.4
17	080628	23.9	**14.0**	37.9
18	080618	22	**13.8**	35.8
19	080624	27.9	**13.6**	41.5
20	080724	12.6	**13.4**	26.0

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Table B6 - Peak PM_{10} 24 hour Impacts Sorted by Order of Decreasing Background Concentrations

24 hour PM_{10} Concentrations (µg/m³)				
Rank	**Date (YYMMDD)**	**Background**	**Model Prediction**	**Cumulative Total**
1	80916	**50.1 (17.2)**	4.1	54.2 (21.3)
2	81003	**48.3 (44.0)**	3.6	51.9 (47.6)
3	80702	**45.8 (77.0)**	5.9	51.7
4	81031	**44.5**	3.5	48.0
5	80701	**42.2**	5.2	47.4
6	80922	**40.9**	5.6	46.5
7	71215	**38.9**	0.5	39.4
8	80915	**38.7**	1.4	40.1
9	80920	**38.1**	3.3	41.4
10	81027	**35.8**	1.5	37.3
11	81001	**35.4**	7.2	42.6
12	80714	**34.2**	12.1	46.3
13	80822	**32.8**	10.3	43.1
14	81002	**32.8**	3.3	36.1
15	80718	**31.7**	12.0	43.7
16	80928	**31.5**	3.1	34.6
17	80801	**31.0**	5.2	36.2
18	80911	**31.0**	8.4	39.4
19	80626	**30.9**	5.4	36.3
20	80525	**30.6**	15.8	46.4

Note: shaded cells indicate additional exceedances. Background values in brackets are those recorded at the Gauthorpe St monitoring station for the same period. Cumulative values in brackets are those calculated using the Gauthorpe St monitoring data.

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Table B7 - Peak PM_{10} 24 hour Impacts Sorted by Order of Decreasing Cumulative Total Concentrations

24 hour PM_{10} Concentrations (µg/m³)				
Rank	**Date (YYMMDD)**	**Background**	**Model Prediction**	**Cumulative Total**
1	80916	50.1 (17.2)	4.1	**54.2 (21.3)**
2	81003	48.3 (44.0)	3.6	**51.9 (47.6)**
3	80702	45.8 (77.0)	5.9	**51.7**
4	81031	44.5	3.5	**48.0**
5	80701	42.2	5.2	**47.4**
6	80922	40.9	5.6	**46.5**
7	80525	30.6	15.8	**46.4**
8	80714	34.2	12.1	**46.3**
9	80718	31.7	12.0	**43.7**
10	80822	32.8	10.3	**43.1**
11	80527	28.1	14.5	**42.6**
12	81001	35.4	7.2	**42.6**
13	80526	29.4	12.5	**41.9**
14	80624	27.9	13.6	**41.5**
15	80920	38.1	3.3	**41.4**
16	80715	27.3	14.1	**41.4**
17	80703	23.4	17.2	**40.6**
18	80915	38.7	1.4	**40.1**
19	80521	27.9	11.9	**39.8**
20	80911	31	8.4	**39.4**

Note: shaded cells indicate additional exceedances. Background values in brackets are those recorded at the Gauthorpe St monitoring station for the same period. Cumulative values in brackets are those calculated using the Gauthorpe St monitoring data.

B.4 Analysis of Meteorological Influences on Peak PM_{10} Impacts

The following section provides information on potential meteorological influences on dust dispersion. This data is most pertinent to the analysis of the dust dispersion behaviours of the model, and has some implications for potential dust management strategies. **Figures B2** through to **Figure B7** show the scale of predictions against a range of meteorological parameters, normalised to the maximum predicted concentration at the receptor location (Cmax).

Figure B2 – Hourly PM_{10} Concentration Vs Wind Speed

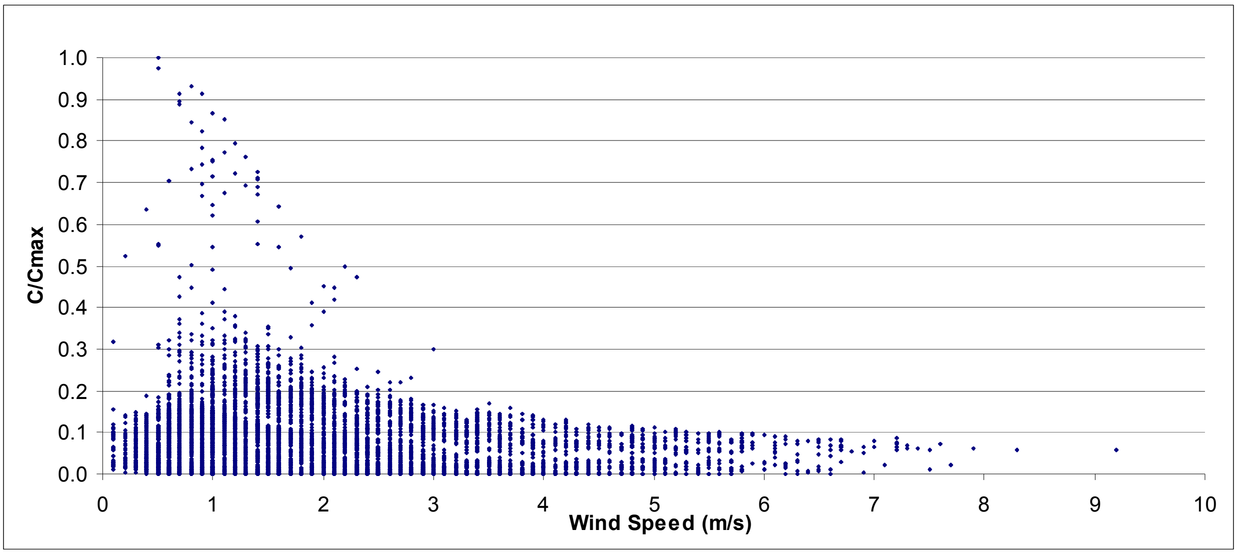

Figure B3 - Hourly PM_{10} Concentration Vs Mixing Height

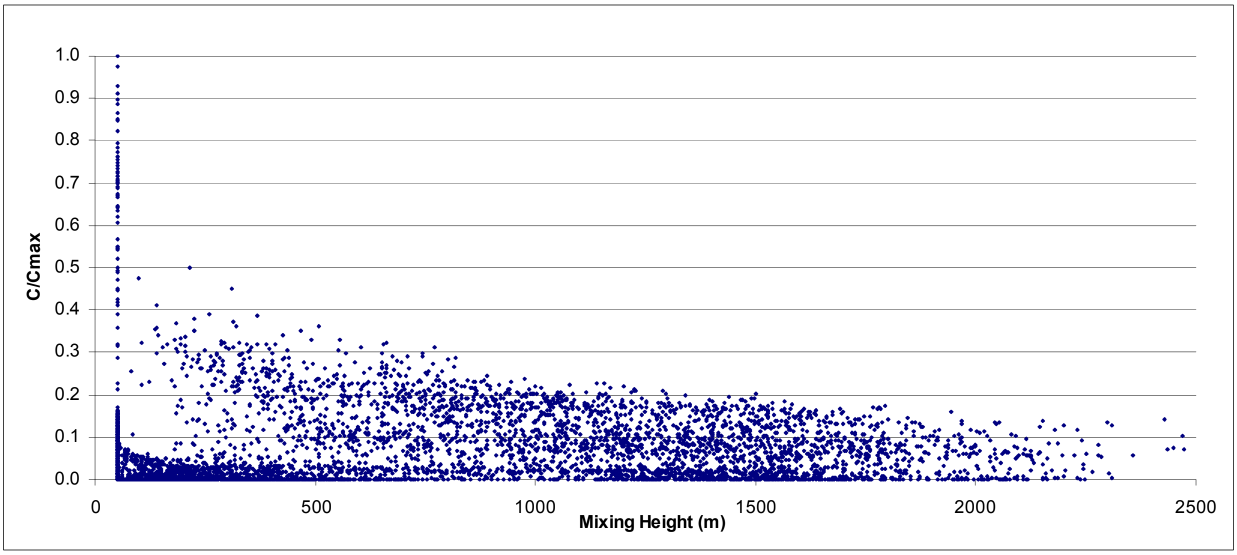

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Figure B4 Hourly PM_{10} Concentration Vs Stability Class

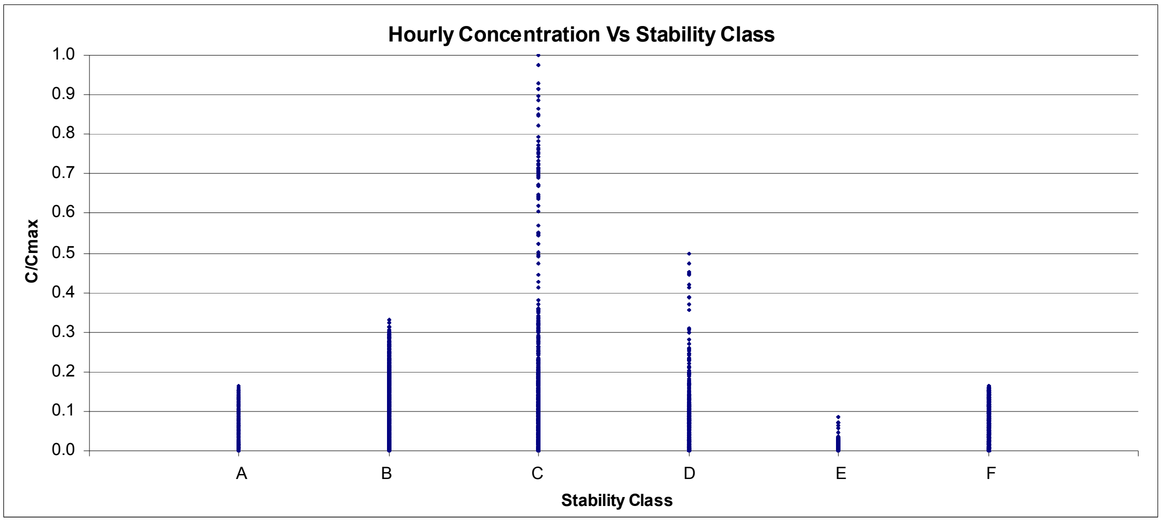


Figure B5 - Hourly PM_{10} Concentration Vs Wind Direction

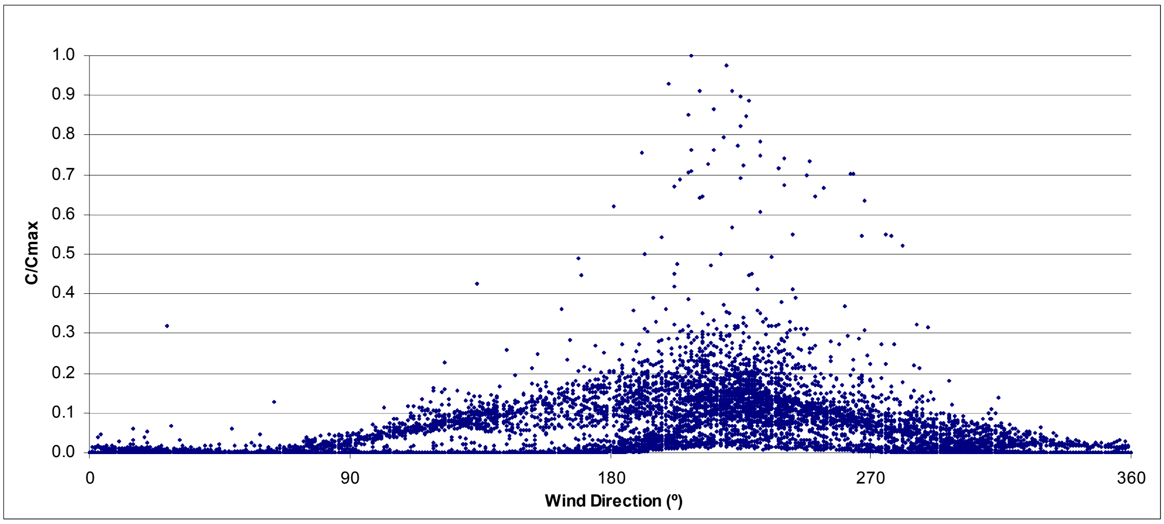


Figure B6 - Hourly PM10 Concentration Vs Ambient Temperature

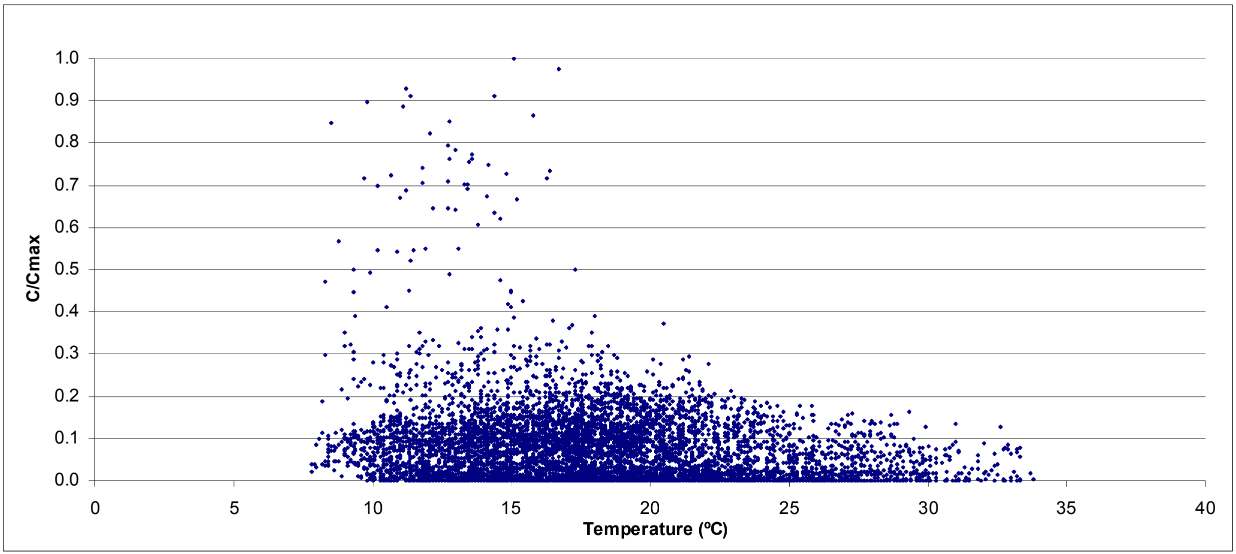
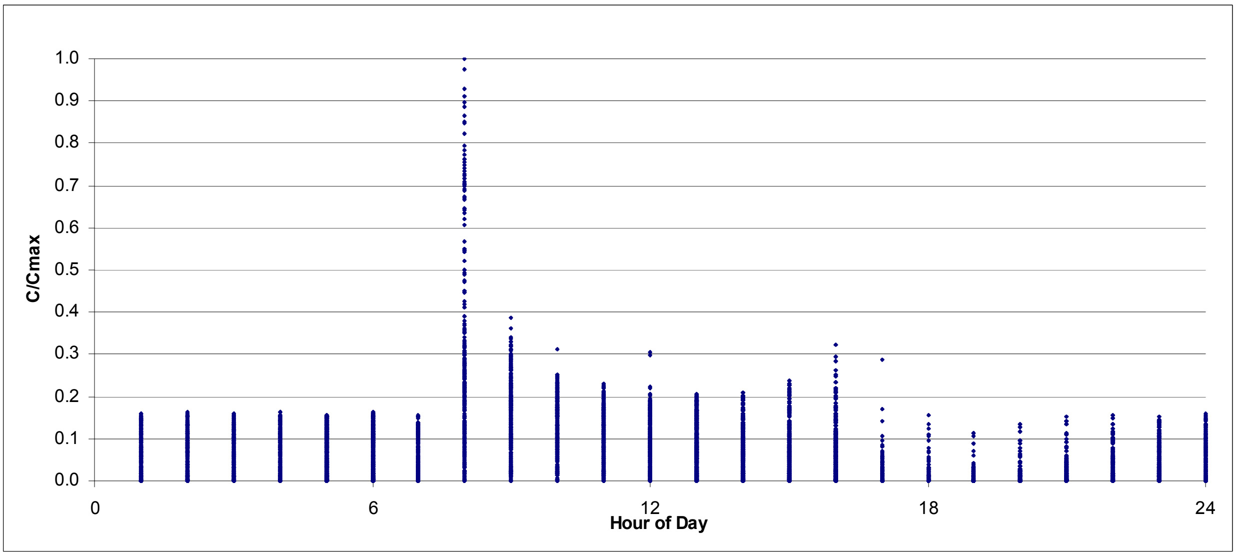


Figure B7 - Hourly PM_{10} Concentration Vs Hour of Day



Summary of Charts

Hourly impacts greater than approximately 50% of the peak, were predicted to occur under the following conditions:

- Wind speeds less than 2m/s;
- A mixing height of 50m (an internal limit of the model);
- 'C' Class Stability;
- Southerly Winds;
- Cooler Temperatures; and
- Close to dawn.

Implications of Meteorological Analysis for Mitigation Strategies

The analysis in **Figures B2** through to **Figure B7** shows that worst case dispersion occurs under calm stable to neutral conditions, which demonstrates the importance of ensuring that control measures are adequate under these conditions.

It should be noted however that the modelling has used emission rates which are not dependent upon ambient meteorology (in particular wind speed), which limits the application of the model predictions to the designation of mitigation strategies, i.e. whilst calm, stable conditions reflect the worst case dispersion scenario, low wind conditions are likely to result in lower emission rates than those used in the modelling, and conversely high wind conditions are likely to result in increases in the mass of dust emitted from the sites. In reality, (outside of the model), the presence of increased dust emissions during high wind speed conditions places a greater emphasis on the importance of mitigation under high wind conditions than would be implied by the model results alone.

B.5 Analysis of PM_{10} Predictions by Source Contribution

In order to better define the relative importance of potential mitigation measures, an analysis of source contribution was performed. This analysis has also been used to provide some additional context on the emissions estimation for key source types. **Table B8** provides the relative contribution for the 25 highest total incremental impacts, based upon the model predictions for a receptor at ground level midway alongthe southern boundary of Lot 100.

Table B8 - Contribution to Top 25 24hr Incremental PM10 Impacts

Contribution to 24 hour Incremental PM_{10} Impact - by Source Type and Site (µg/m³)													
Rank	Lednez Stacks	All Excavators	All Haul Roads	All Loading	All Erosion	Allied Feeds Total	Lednez Total	Haul Roads (AF)	Haul Roads (LZ)	Excavators (AF)	Excavators (LZ)	Haul Road Adjacent to Lot 100	ALL SOURCES
1	0.5	0.9	10.0	0.7	5.1	9.0	8.1	7.8	2.2	0.4	0.4	5.1	**17.2**
2	0.2	0.5	8.7	0.5	6.6	8.4	8.0	7.2	1.5	0.2	0.3	4.4	**16.5**
3	0.2	0.4	8.4	0.5	6.2	8.0	7.8	7.0	1.4	0.1	0.3	4.4	**15.8**
4	0.0	0.5	9.2	0.5	5.0	9.1	6.2	7.8	1.4	0.3	0.3	4.4	**15.3**
5	0.5	0.6	9.6	0.5	4.1	8.3	7.0	7.2	2.4	0.3	0.3	4.8	**15.3**
6	0.3	0.5	7.2	0.5	6.8	7.1	8.2	5.8	1.4	0.2	0.3	3.1	**15.3**
7	0.3	0.6	8.3	0.5	5.6	8.2	7.0	6.9	1.3	0.3	0.3	4.5	**15.2**
8	0.3	0.3	7.8	0.5	6.3	7.0	8.1	6.3	1.4	0.1	0.2	3.4	**15.1**
9	0.2	0.6	9.0	0.6	4.7	8.4	6.6	7.5	1.5	0.2	0.3	4.3	**15.0**
10	0.3	0.3	6.7	0.4	7.2	6.6	8.3	5.6	1.1	0.1	0.2	3.2	**14.9**
11	0.4	0.4	8.9	0.5	4.7	8.1	6.7	7.5	1.4	0.1	0.3	4.6	**14.8**
12	0.3	0.5	7.5	0.5	5.9	7.2	7.4	6.1	1.4	0.1	0.3	3.5	**14.6**
13	0.3	0.4	7.9	0.6	5.4	7.2	7.3	6.4	1.5	0.1	0.3	3.4	**14.5**
14	0.0	0.3	6.9	0.4	6.5	6.8	7.3	5.7	1.1	0.0	0.2	2.7	**14.1**
15	0.4	0.5	7.8	0.5	4.8	7.4	6.5	6.4	1.4	0.1	0.3	3.5	**14.0**
16	0.0	0.2	7.0	0.3	6.3	7.3	6.4	6.0	1.0	0.1	0.1	3.1	**13.7**
17	0.0	0.5	6.8	0.4	5.8	7.0	6.6	5.6	1.2	0.3	0.3	2.9	**13.6**
18	0.2	0.3	7.1	0.2	5.8	7.8	5.8	6.5	0.6	0.2	0.1	4.1	**13.6**
19	0.0	0.4	8.0	0.4	4.5	7.8	5.6	7.0	1.0	0.3	0.2	5.1	**13.4**
20	0.6	0.6	7.2	0.4	4.5	6.2	7.0	5.8	1.4	0.2	0.4	3.8	**13.2**
21	0.2	0.2	6.8	0.3	5.6	6.9	6.3	6.0	0.9	0.1	0.1	3.6	**13.1**
22	0.1	0.4	7.5	0.5	4.6	7.5	5.6	6.3	1.3	0.1	0.3	3.3	**13.1**
23	0.8	0.6	6.9	0.4	4.4	6.5	6.5	5.6	1.3	0.2	0.3	3.7	**13.0**
24	0.2	0.3	7.3	0.4	4.8	6.9	6.1	6.2	1.1	0.1	0.2	3.8	**13.0**
25	0.3	0.3	6.0	0.2	6.2	6.6	6.3	5.5	0.5	0.2	0.1	4.4	**12.9**

In addition, **Figures B8** through to **Figure B10** provide a graphical representation of these source groups for all days of the modelling period.

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Particulate Matter Assessment for Residential occupation of Lot 100

Figure B8 – Percentage Contribution to Incremental 24 hour PM10 Impact – by Source Type and Site

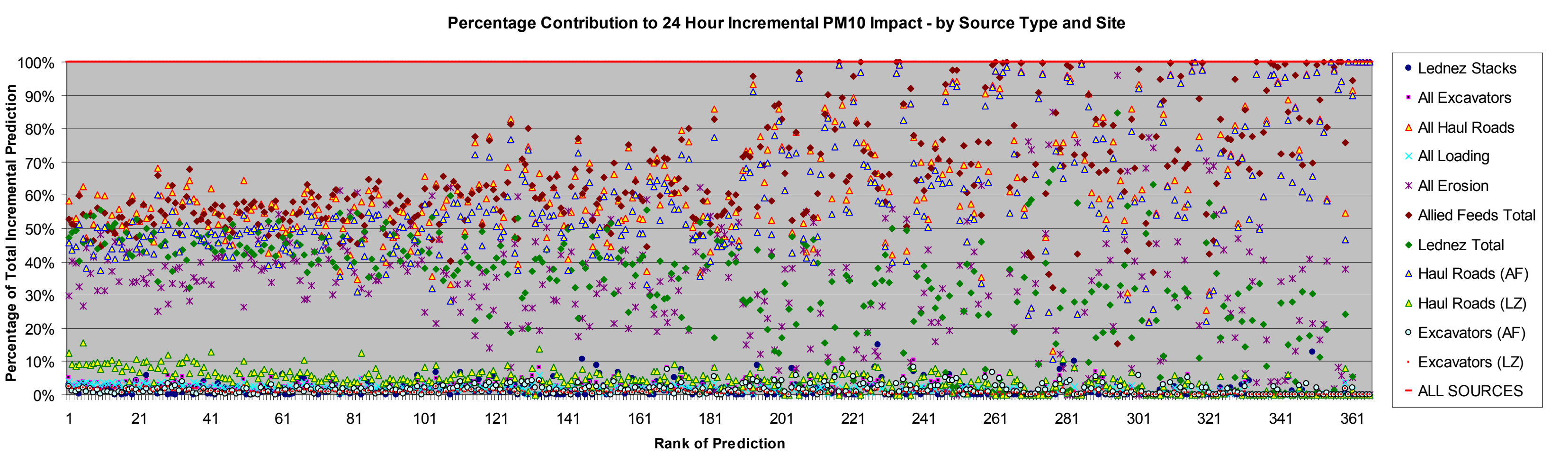
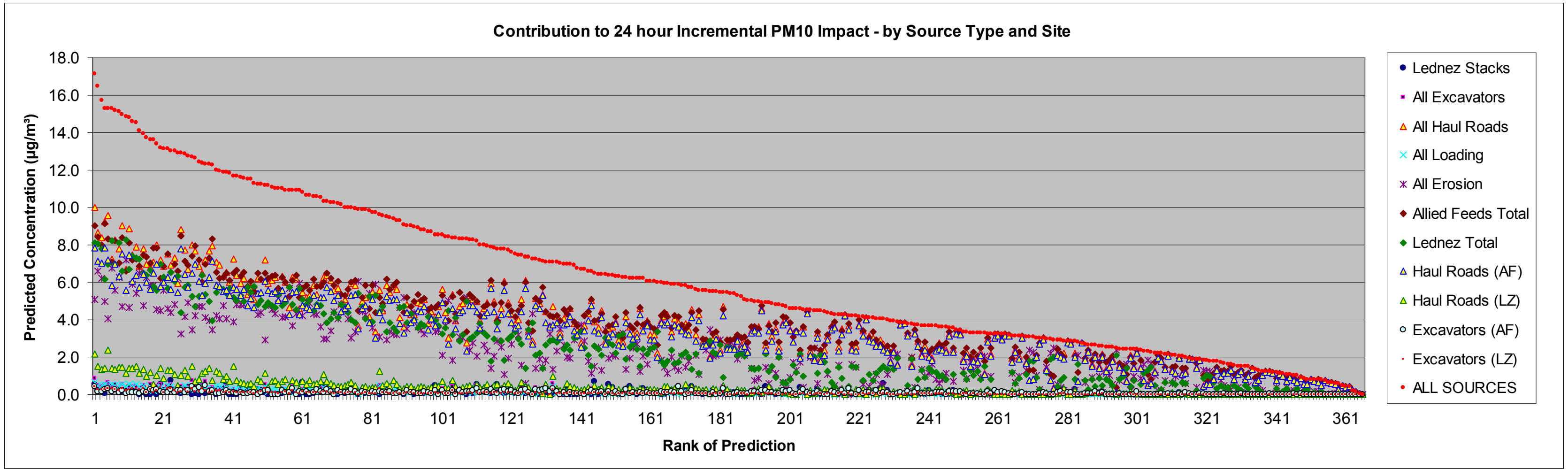


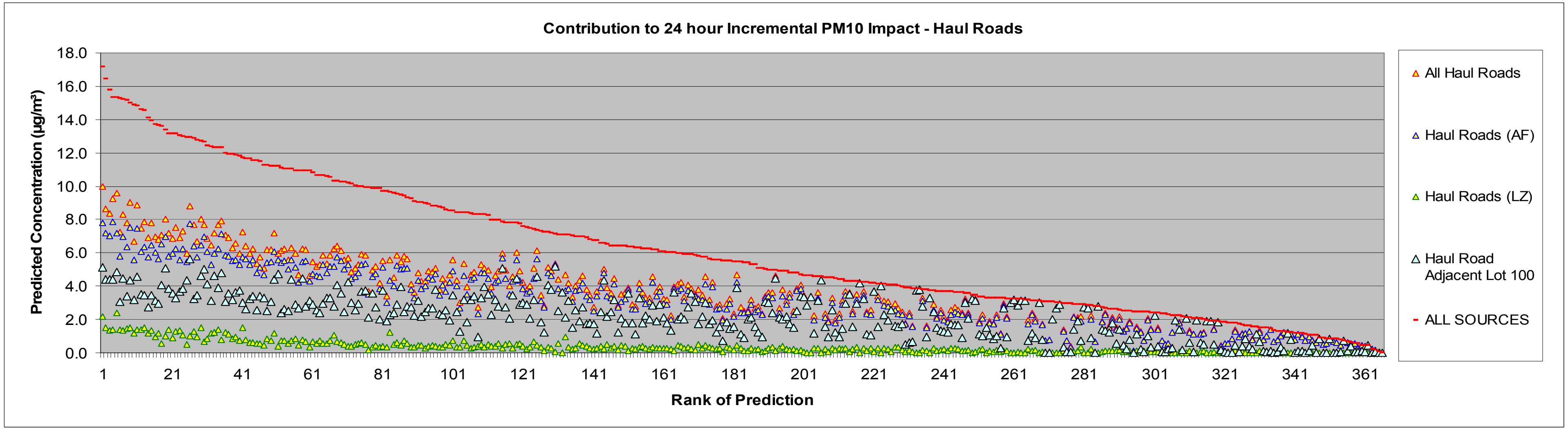
Figure B9 – Contribution to Incremental 24 hour PM10 Impact – by Source Type and Site



Appendix B

Particulate Matter Assessment for Residential occupation of Lot 100

Figure B10 - Contribution to Incremental 24 hour PM10 Impact – Haul Roads



Appendix B Particulate Matter Assessment for Residential occupation of Lot 100

As can be seen in **Figures 1** through to **Figure 3**, the peak PM_{10} impacts are generated by the following source types in order of greatest impact:

1. Haul road emissions - around 50% to 60% of the total peak incremental PM_{10} impacts result from these emissions.
2. Wind blown dust from exposed areas - around 30% to 40% of the total peak incremental PM_{10} impacts result from these emissions.
3. All other source types – less than 10% of the total peak incremental PM_{10} impacts result from these emissions.

As can be seen in **Figure B11** dust deposition at the Lot 100 is also dominated by emissions from haul roads.

B.5.4 Discussion of Haul Road Emissions

Given the dominance of haul road emissions in defining predicted dust levels, additional context has been provided for the haul road emission estimation. In particular, elements of the estimation that are considered of interest have been highlighted, such that better qualification of the model predictions can be made. This discussion also has implications for the feasibility of mitigation measures.

Haul Road Watering

The dust modelling performed as part of the HHRA has utilised the current US-EPA AP-42 emission factors with an NPI emission reduction factor of 90% for haul road watering. This is in accordance with the current US EPA AP-42 emission factors[6], whereby a 90% control can be achieved by a fourfold increase in the surface moisture content.

In Holmes air sciences (2006)[7] an emission reduction of 90% for haul road watering was utilised for a coal mine in the Hunter Valley of NSW. Whilst the long-term practicality of sustaining this for a large mine with around 10km in haul roads would be challenging, given the small quantity (approximately 500m in total) of roadway on the Allied Feeds site, in conjunction with the need to only water active roadways, it would seem quite feasible that such a control efficiency can be achieved.

Sealing of Haul Roads

Figure B10 shows the contribution from the haul road adjacent to Lot 100, where around 5µg/m³ of the total incremental impact results from this small stretch of road in isolation, and around 8µg/m³ of the total incremental impact results from all haul roads on the Allied Feeds Site. Currently, infrastructure associated with the remediation works prevents Meriton from sealing these roads, however, Meriton propose to seal this section of road as a matter of priority. Furthermore, Meriton propose to seal all roads adjacent to Lot 100 within 6 months of Thiess completing works on the site. Meriton also propose to seal all haul roads on the Allied Feeds Site within 6-12 months of Thiess' completion. Provided that the silt loading of the sealed road surface is managed, this would reduce the reliance on haul road watering that has been assumed in this assessment.

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[6] US EPA (2006) AP 42, Fifth Edition, Volume I, Chapter 13, Section 2.2: *Miscellaneous Sources* http://www.epa.gov/ttn/chief/ap42/ch13/final/c13s0202.pdf

[7] Holmes Air Sciences (2006), *Air Quality Impact Assessment: Anvill Hill Project,* August 2006 http://www.umwelt.com.au/anvil-hill/docs/Appendix10-Air.pdf

Hauling Speed

The assessment has not applied any emissions reduction as a result of the low speed of vehicles on the site. Vehicles on the Allied Feeds site are currently speed limited to 10 km/h, and Meriton do not propose to change this during the period of construction. Whilst the current US EPA AP-42 unsealed road emission factors do not contain a speed dependence, the current sealed road emission factors[8], as well as previous unsealed road emission factors have included a speed dependence. SKM (2005)[9] contains a review of, and suggested improvements to, the current NPI estimation methods. The author considers the absence of such speed dependence to be unrealistic and notes the following in relation to these factors:

"As such, for cases for vehicle speeds less than 15 mph, AP-42 (1998) recommended multiplying the emission factor by S/15 where S is the mean vehicle speed in mph."

"That the...(current)*...equation for industrial sites does not have speed dependence is surprising. Anecdotal evidence suggests that for many of the larger pits in WA with long inclines, vehicle speeds are very low (<15 km/hr) with particulate matter emissions that appear to be minimal."*

Given the low speed of vehicles on the site, it is considered that the omission of this factor from emission estimates represents an additional conservative element of the HHRA.

B.6 Background Monitoring Data

An element of conservatism in the HHRA was that the particulate matter background monitoring data was collected during a time that dust emitting activities of a near identical scale to those considered in the assessment scenario were already occurring on both the Allied Feeds and Lednez sites.

This means that the cumulative figures in the assessment reflect the total impact due to the following factors:

- Background levels PM_{10} levels in Rhodes/Sydney region;
- The impact associated with dust emitting activities on the Allied Feeds and Lednez sites (as measured by the monitor); and
- The impact associated with dust emitting activities on the Allied Feeds and Lednez sites (as predicted by the model).

To provide an indication of the extent of this potential double counting of dust emissions from the Allied Feeds and Lednez sites, some additional analysis of the modelling has been performed. **Figure 11** shows the model predictions at the monitoring site, relative to model predictions at ground level midway along the southern boundary of Lot 100. The plotted series in **Figure 11** show the 100 worst impacts at Lot 100, and the corresponding predicted impact at the Blaxland Road monitoring site.

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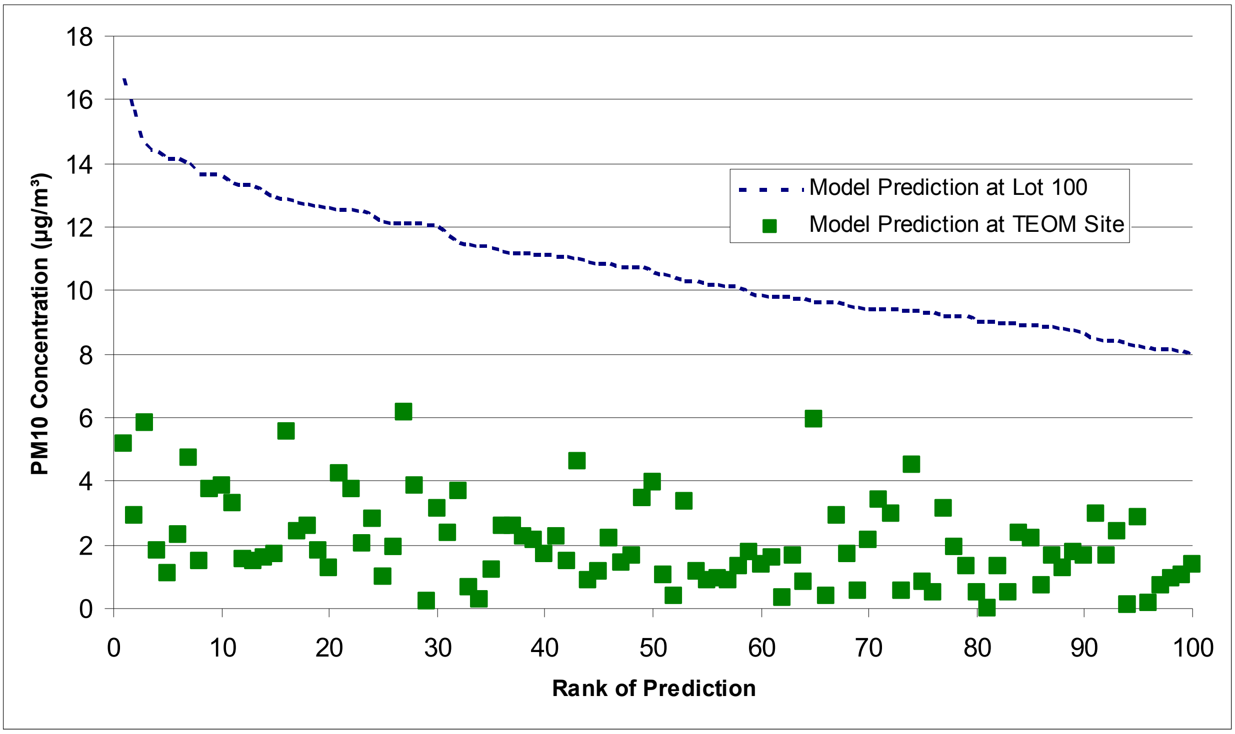
8 US EPA (2006) AP 42, Fifth Edition, Volume I, Chapter 13, Section 2.1: *Miscellaneous Sources* http://www.epa.gov/ttn/chief/ap42/ch13/final/c13s0201.pdf

9 SKM (2005), *Improvement of NPI Fugitive Particulate Matter Emission Estimation Techniques* (May 2005) http://www.npi.gov.au/handbooks/pubs/pm10may05.pdf

Figure 11 - Top 100 PM_{10} Predicted Impacts at Ground Level Lot 100 against Contemporaneous Prediction at TEOM Monitoring Site



On the basis that the dust emitting activities during the time of the monitoring were similar to those considered in the modelling assessment, the worst case top 30 impacts have been over-predicted by an average of 3 µg/m^3.

B.7 Dust Mitigation and Monitoring

Dust Mitigation

The following practices could be employed for the mitigation of dust impacts:

- Watering of Haul Roads, minimising vehicle movements, and restricting vehicle speeds;
- In dry, windy conditions, water sprays would be used to dampen down soils prior to excavation and handling. Exposed surfaces and stockpiles would also be watered, sprayed or covered where required;
- Where practical, particularly dusty works would be scheduled under favourable meteorological conditions only. Earth-moving activities would be stopped when wind speeds exceed 30 km/hr;
- Any long-term stockpiles or cleared areas would be stabilised using measures such as fast-seeding grass or synthetic cover spray;
- Minimising exposed surface areas;

- Vehicles would only be loaded to less than the height of the side and tailboards and loads would be covered during transport;
- Any soil adhering to the undercarriage and wheels of trucks would be removed prior to departure from the site.
- Cleaning of sealed roads as required.

Real Time Particulate Monitoring

The following details outline a potential monitoring strategy:

- Monitor Type: Real Time (Continuous) PM_{10} Light Scattering Dust Monitor (e.g. DustTrak®)
- Location: At the southern boundary of Lot 100
- Trigger Thresholds: Instantaneous: 1000 µg/m^3 / Hourly: 200 µg/m^3

Upon reaching a trigger threshold, work practices would be reviewed, with the implementation of mitigation strategies as appropriate.

Appendix B Particulate Matter Assessment for Residential occupation of Lot 100

B.8 Conclusions

A dispersion modelling assessment was performed in order to assess potential impacts of emissions of particulate matter on residential receptors at Lot 100, 42 Walker St Rhodes.

Based on the predictions of the dispersion model, levels of Total Suspended Particulate and Dust deposition were found to be within regulatory criteria. On a cumulative basis (i.e. incorporating background dust levels), emissions of PM_{10} were found to generate an additional exceedance of regulatory criteria on a single instance. Given the small scale of the exceedance, the minor contribution of the model prediction on this occasion, and the likely double counting of emissions from Lednez and Allied Feeds sites (between the model and the monitoring data), this exceedance is not considered significant.

In addition, analysis of the model predictions contained in the document has shown:

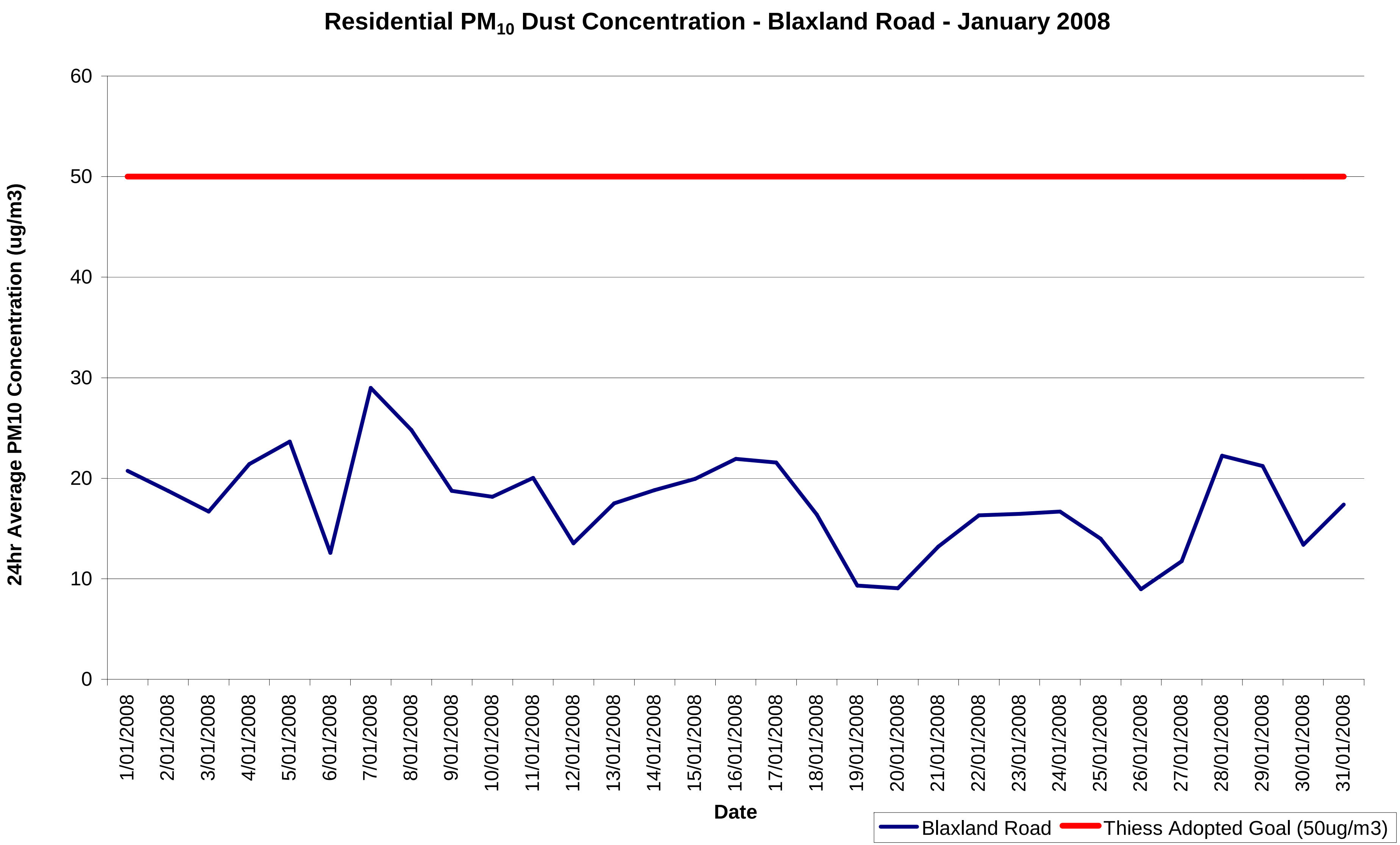
- Around 50% to 60% of the peak total incremental PM_{10} impacts were predicted to result from haul road emissions.
- The emission estimates for haul road emissions included conservative elements that indicate the following:
    - Given the presence of low hauling speeds, and the progressive sealing of the roads on the site, the haul road emission estimates applied in the HHRA are considered conservative.
    - US EPA documentation indicates that the mitigation of dust emissions from haul roads by 90% is feasible.
- Worst case dispersion was predicted to occur under calm, stable conditions.

The information contained in this document and the HHRA indicates that potential dust impacts are of a scale which implies that monitoring and mitigation of the emissions would be a feasible approach to ensuring that dust impacts at Lot 100 are of an acceptable nature to future residents.

Appendix B

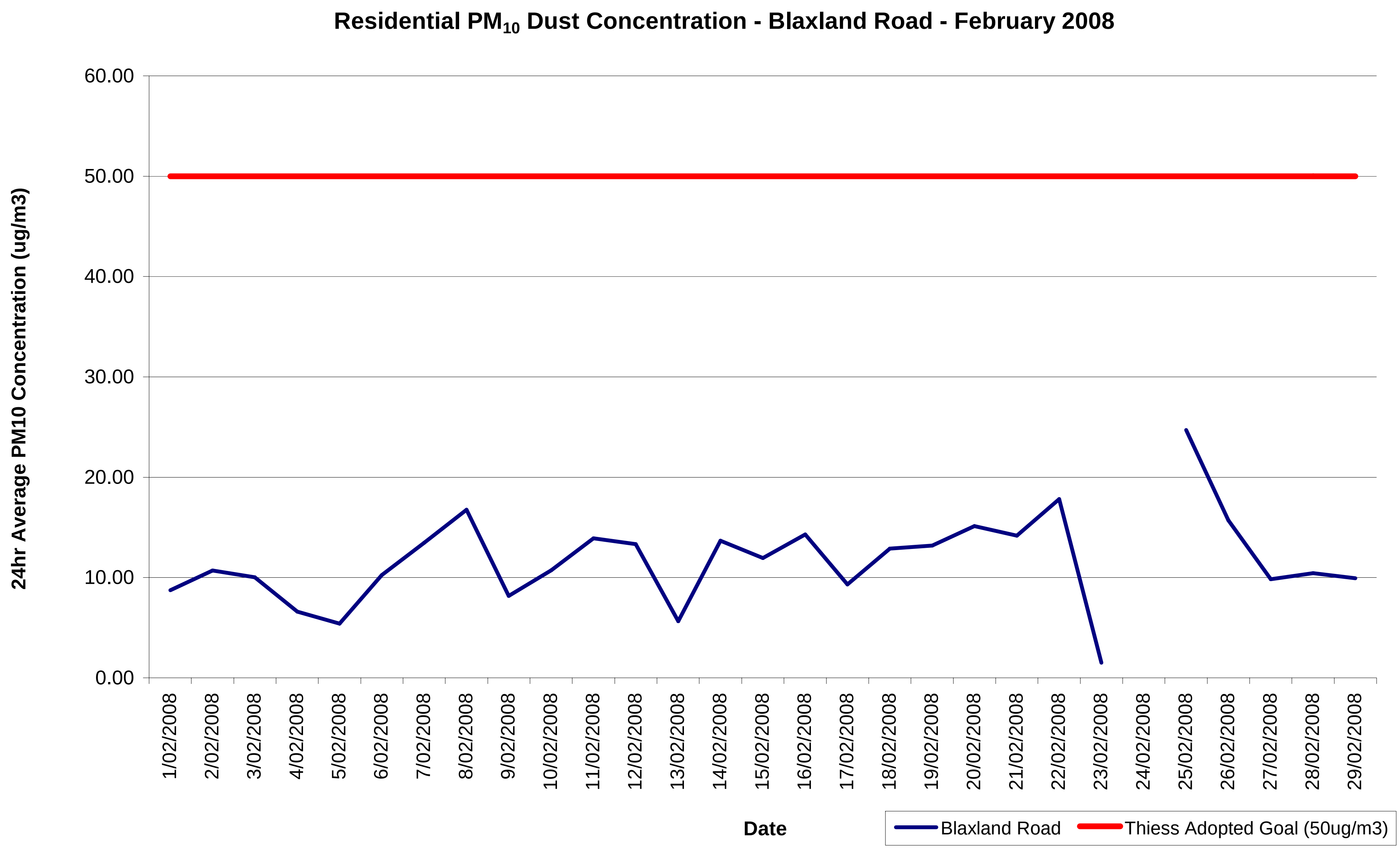
Particulate Matter Assessment for Residential occupation of Lot 100

Attachment 1 – Blaxland Road Particulate Monitoring Results - 2008



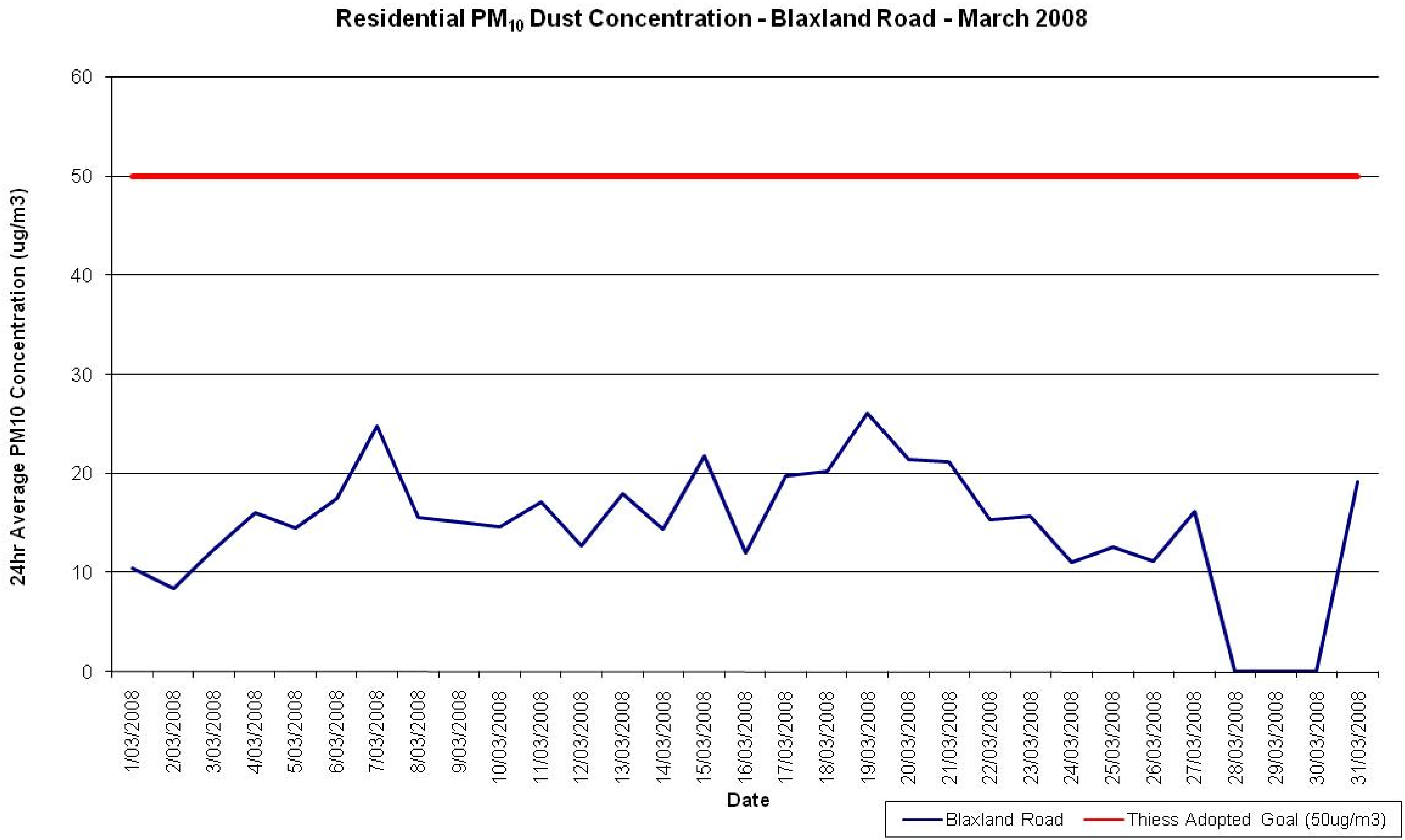
This graph illustrates the PM_{10} dust concentration measured at the residential receptor in Blaxland Road, Rhodes, for the period 1-31 January 2008.

The blue line shows the average 24hr dust concentration (measured in $\mu g/m^3$) and the red line represents the Thiess Air Quality Goal of $50 \mu g/m^3$.



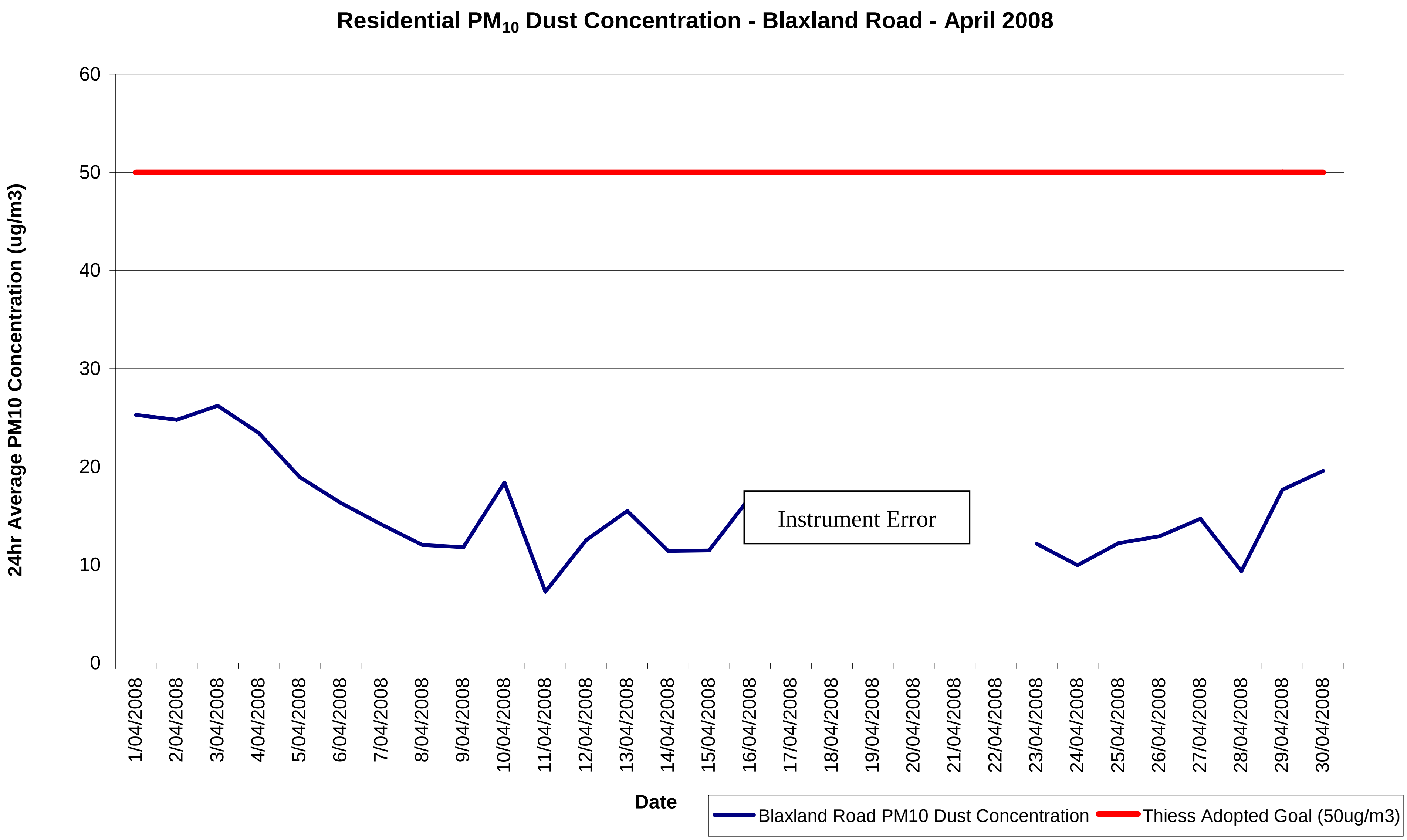
This graph illustrates the PM_{10} dust concentration measured at the residential receptor in Blaxland Road, Rhodes, for the period 1-29 February 2008.

The blue line shows the average 24hr dust concentration (measured in $\mu g/m^3$) and the red line represents the Thiess Air Quality Goal of $50 \mu g/m^3$.

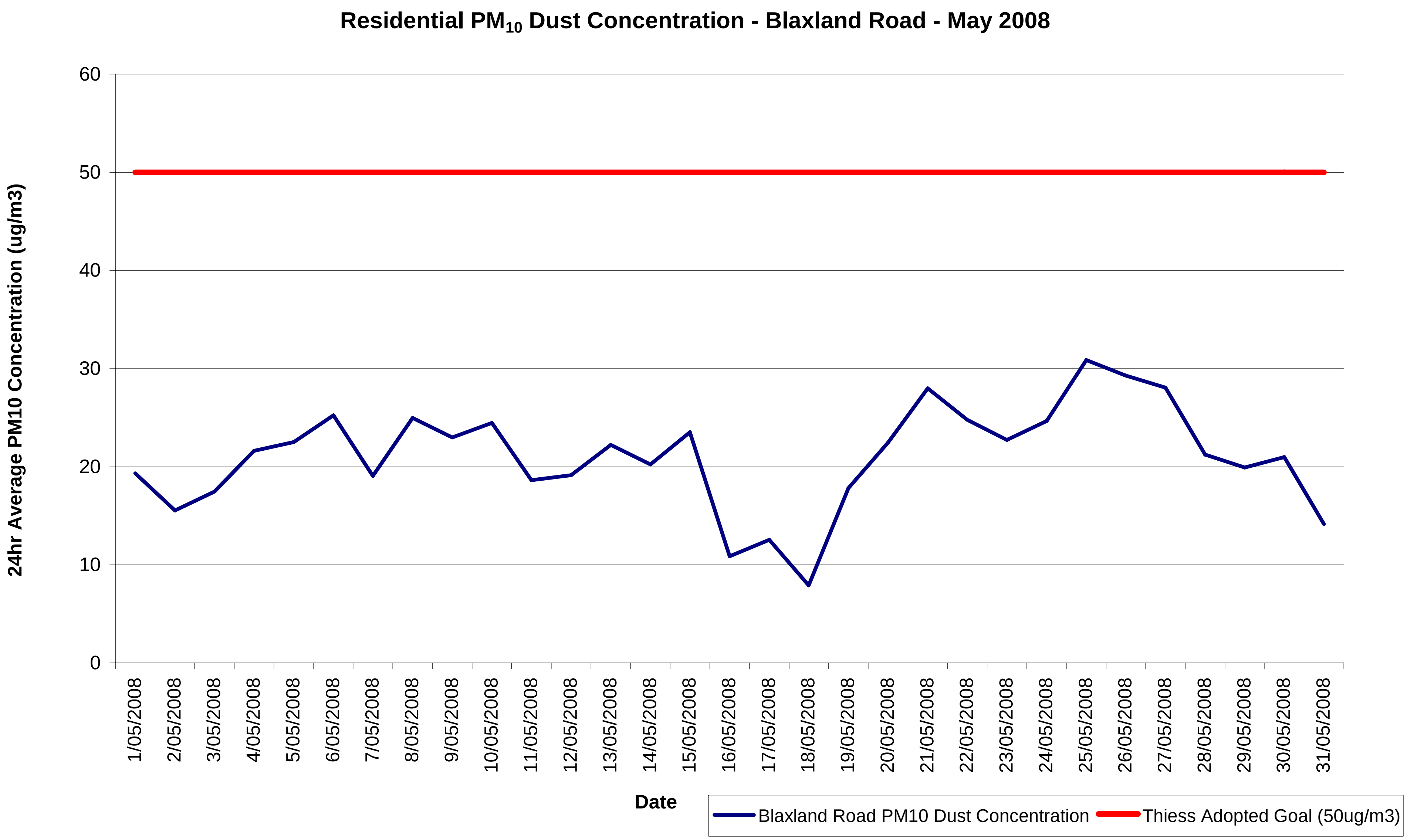


This graph illustrates the PM_{10} dust concentration measured at the residential receptor in Blaxland Road, Rhodes, for the period 1-31 March 2008.

The blue line shows the average 24hr dust concentration (measured in $\mu g/m^3$) and the red line represents the Thiess Air Quality Goal of $50 \mu g/m^3$.

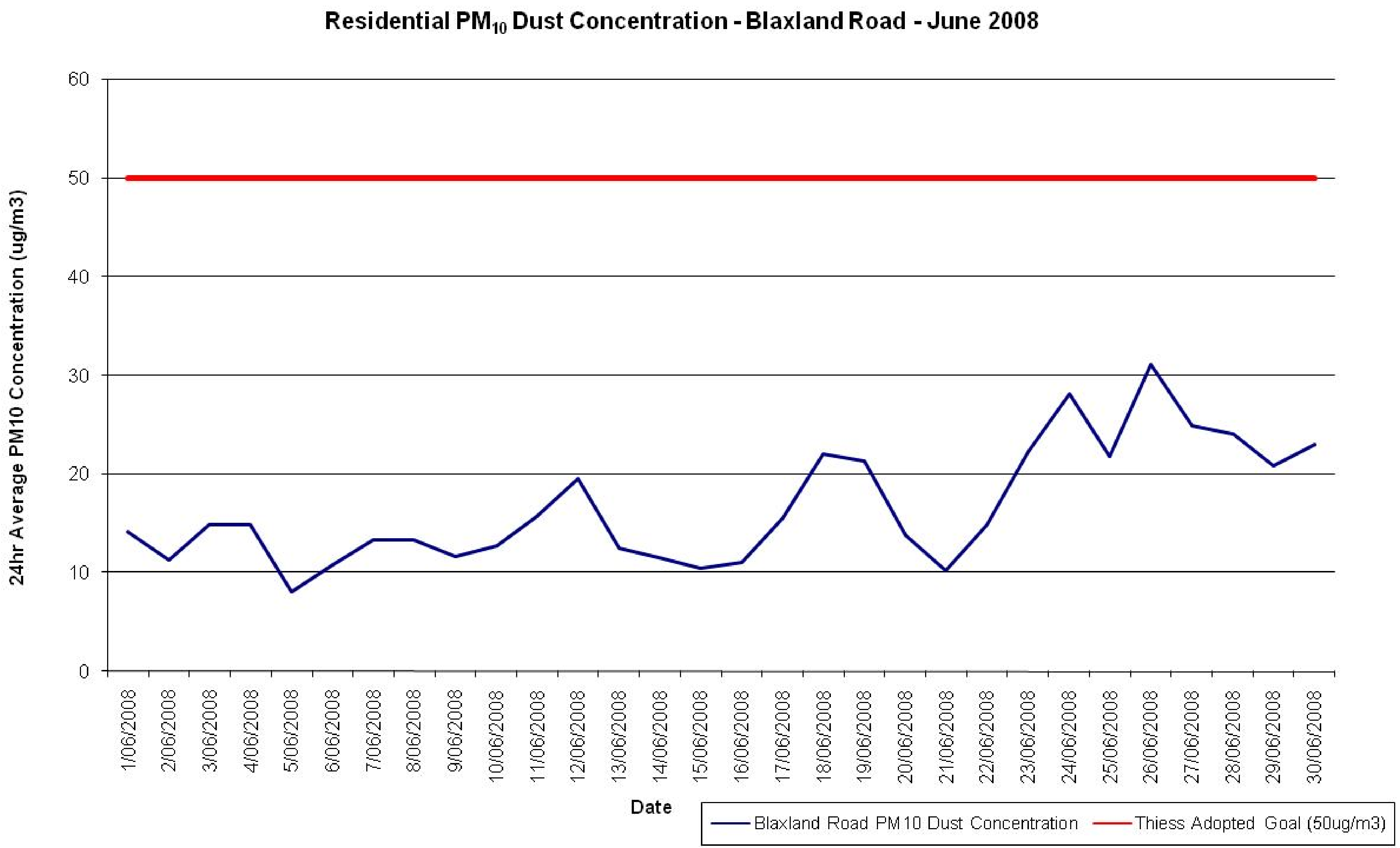


This graph illustrates the PM_{10} dust concentration measured at the residential receptor in Gauthorpe St, Rhodes (‘Sol Rio’ apartments), for the period 1-30 April 2008. The blue line shows the average 24hr dust concentration (measured in $\mu g/m^3$) and the red line represents the Thiess Air Quality Goal of $50 \mu g/m^3$.



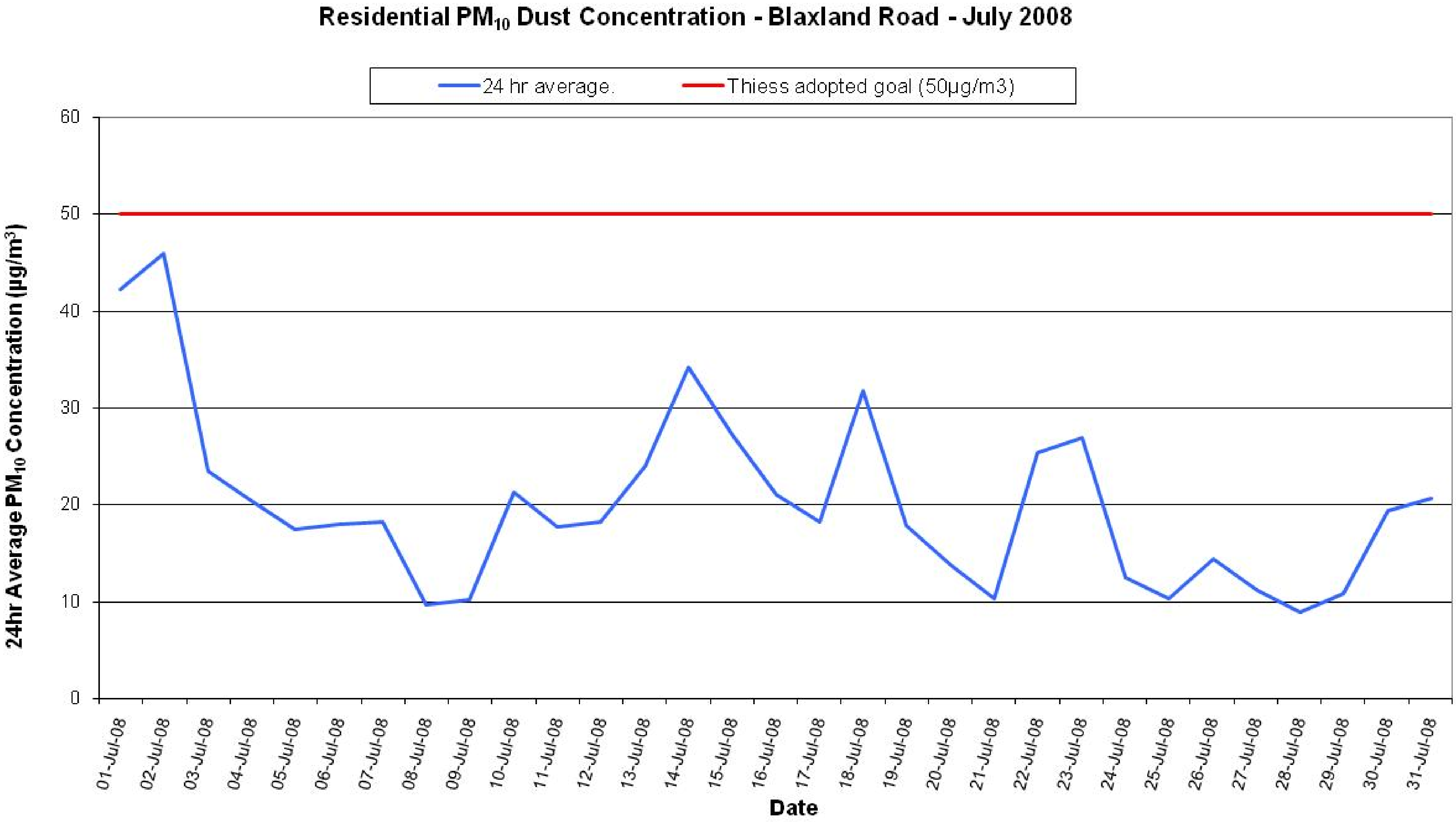
This graph illustrates the PM_{10} dust concentration measured at the residential receptor in Blaxland Road, Rhodes, for the period 1-31 May 2008.

The blue line shows the average 24hr dust concentration (measured in $\mu g/m^3$) and the red line represents the Thiess Air Quality Goal of $50 \mu g/m^3$.



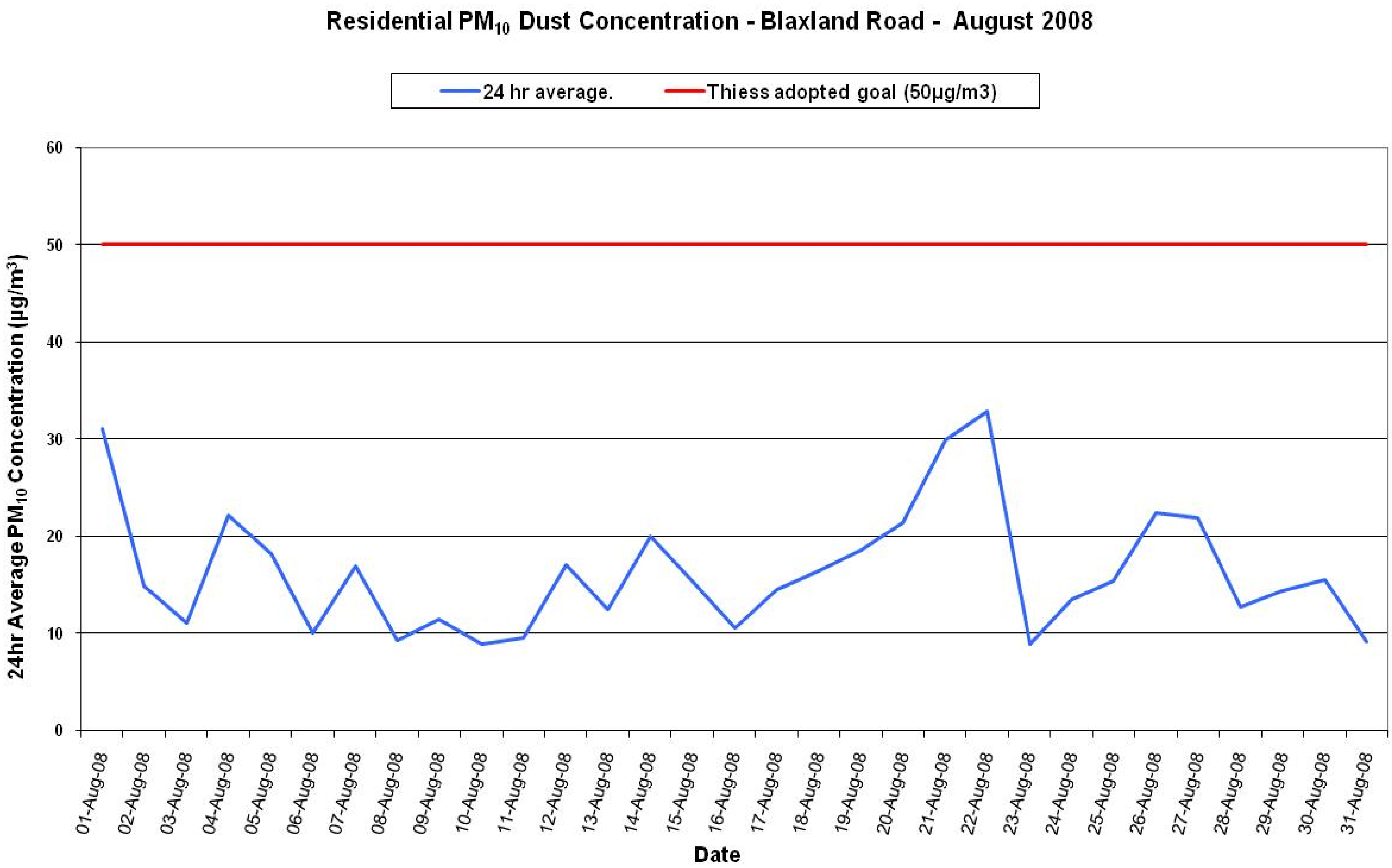
This graph illustrates the PM_{10} dust concentration measured at the residential receptor in Blaxland Road, Rhodes, for the period 1-30 June 2008.

The blue line shows the average 24hr dust concentration (measured in $\mu g/m^3$) and the red line represents the Thiess Air Quality Goal of $50\mu g/m^3$.

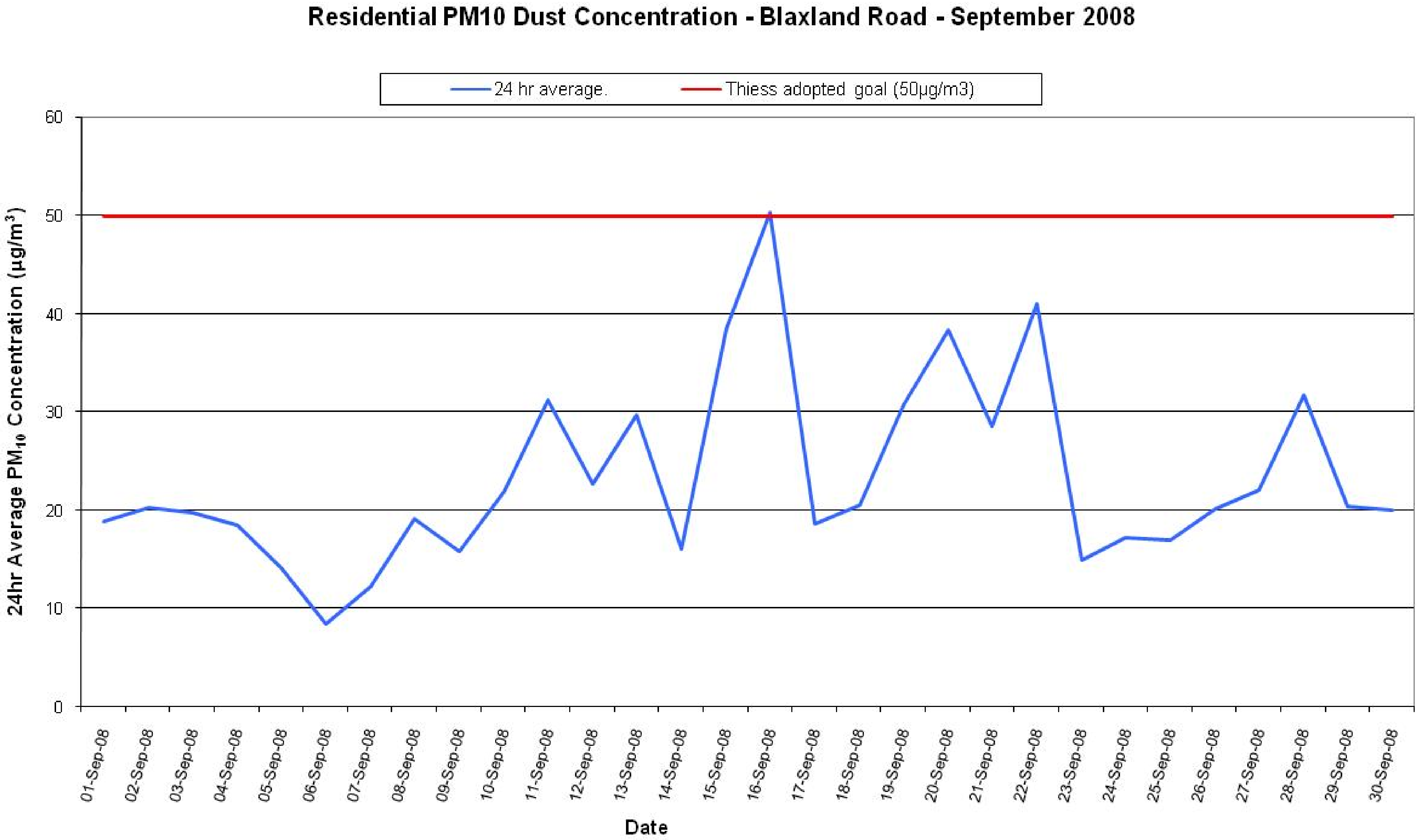


This graph illustrates the PM_{10} dust concentration measured at the residential receptor in Blaxland Road, Rhodes, for the period 1-31 July 2008.

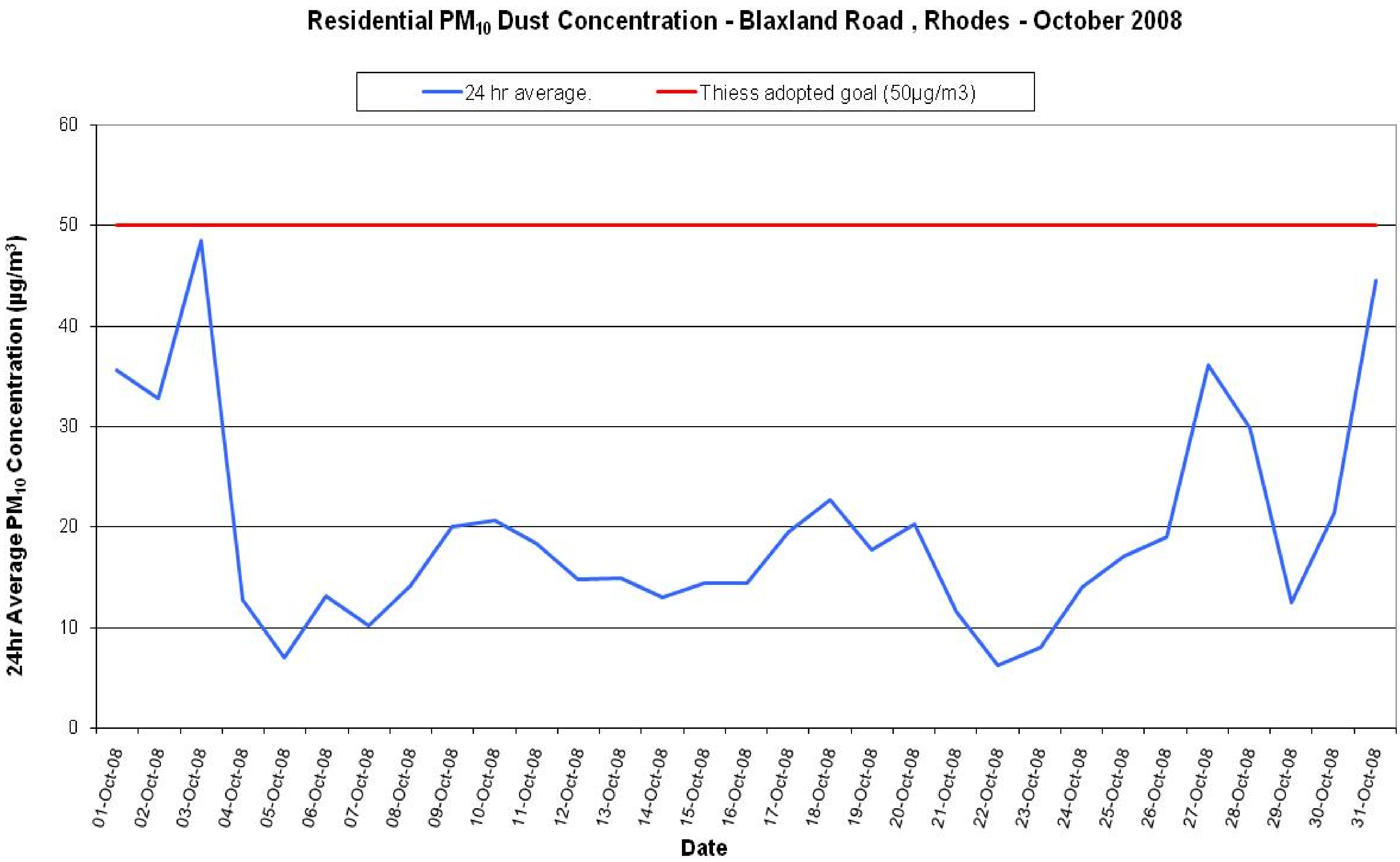
The blue line shows the average 24hr dust concentration (measured in $\mu g/m^3$) and the red line represents the Thiess Air Quality Goal of $50\mu g/m^3$.



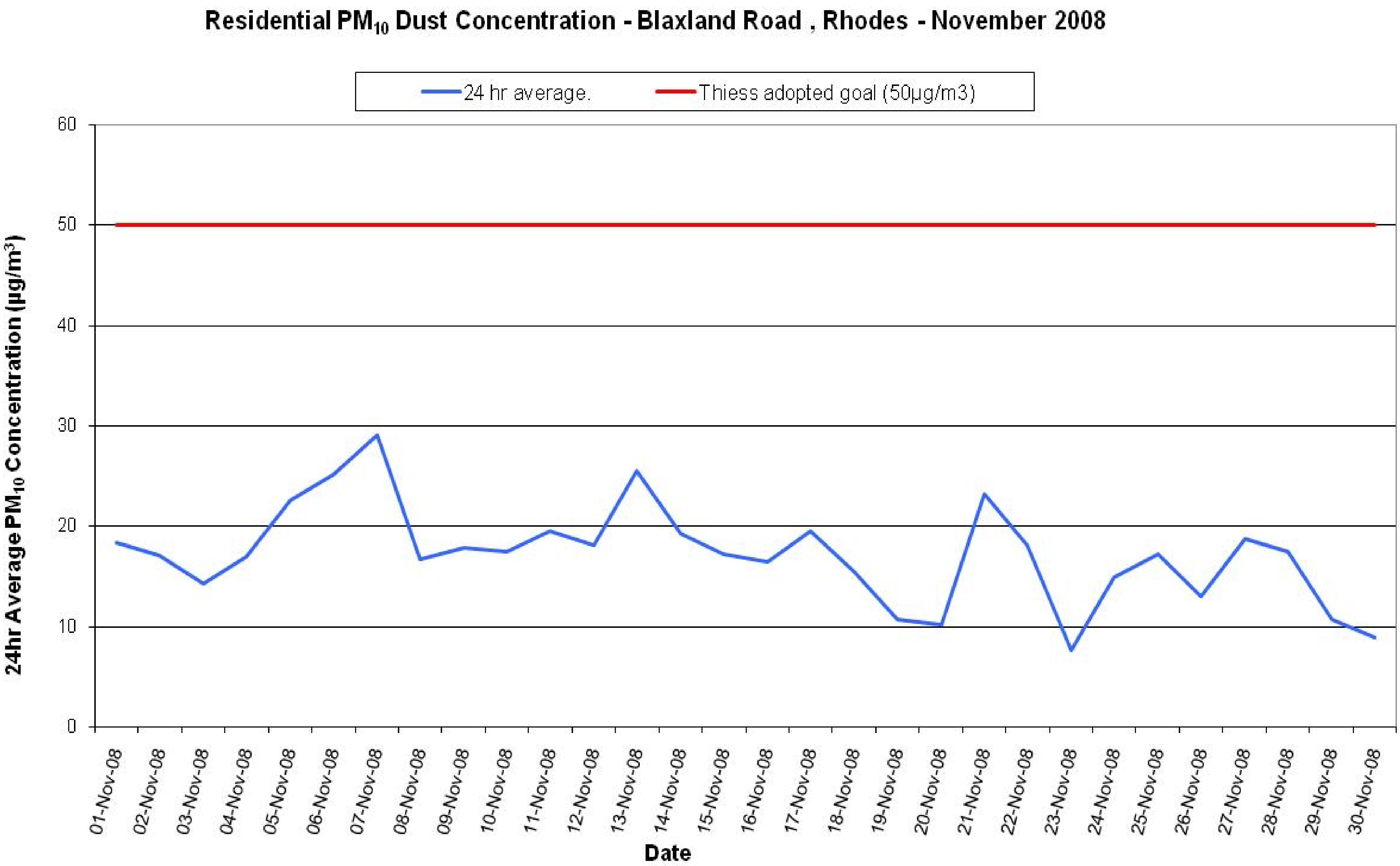
This graph illustrates the PM_{10} dust concentration measured at the residential receptor in Blaxland Road, Rhodes, for the period 1-31 August 2008. The blue line shows the average 24hr dust concentration measured in micrograms per metre cubed ($\mu g/m^3$) and the red line represents the Thiess Air Quality Goal of $50 \mu g/m^3$.



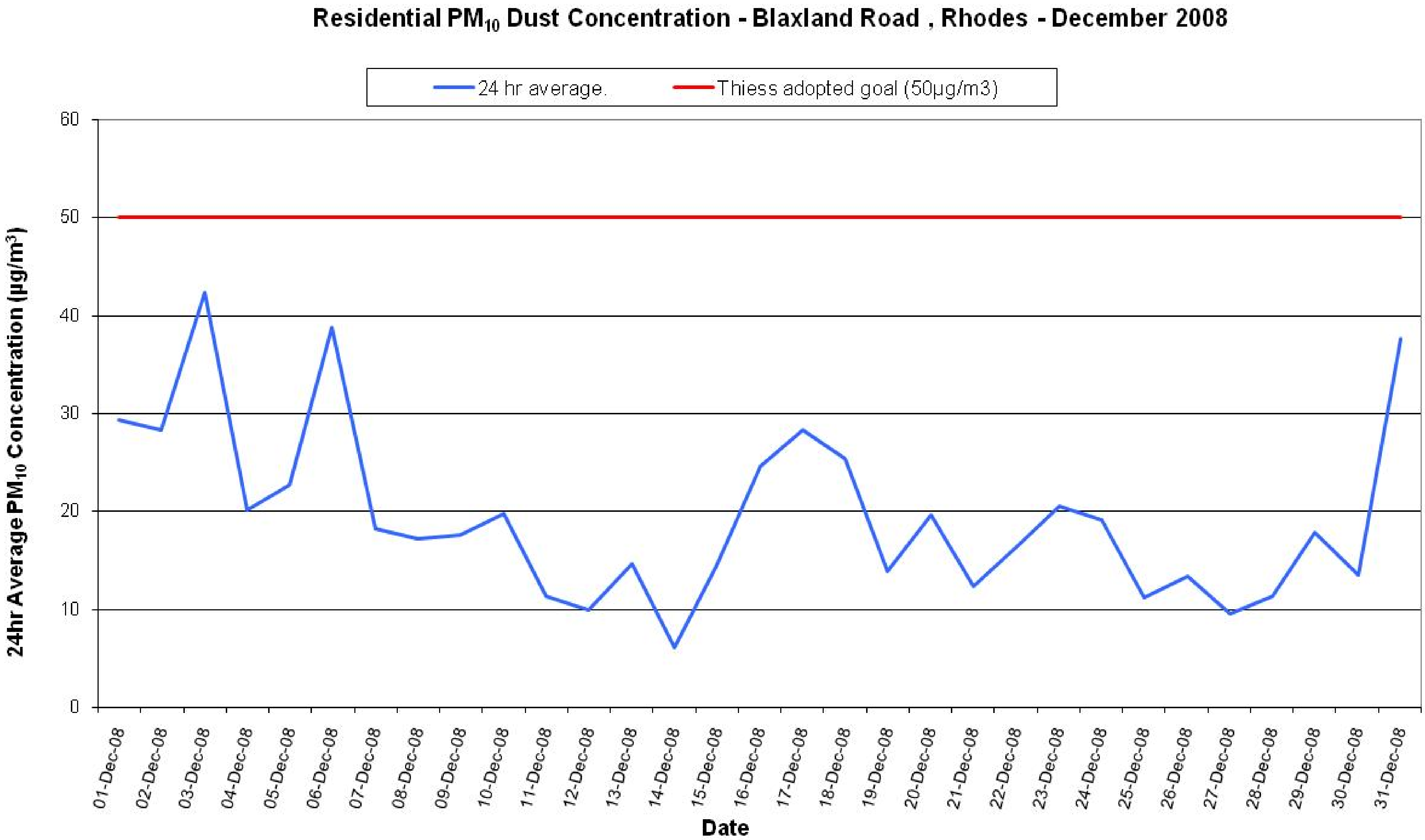
This graph illustrates the PM_{10} dust concentration measured at the residential receptor in Blaxland Road, Rhodes, for the period 1-30 September 2008. The blue line shows the average 24hr dust concentration measured in micrograms per metre cubed ($\mu g/m^3$) and the red line represents the Thiess Air Quality Goal of $50\mu g/m^3$.



This graph illustrates the PM_{10} dust concentration measured at the residential receptor in Blaxland Road, Rhodes, for the period 1-31 October 2008. The blue line shows the average 24hr dust concentration measured in micrograms per metre cubed ($\mu g/m^3$) and the red line represents the Thiess Air Quality Goal of $50\mu g/m^3$.

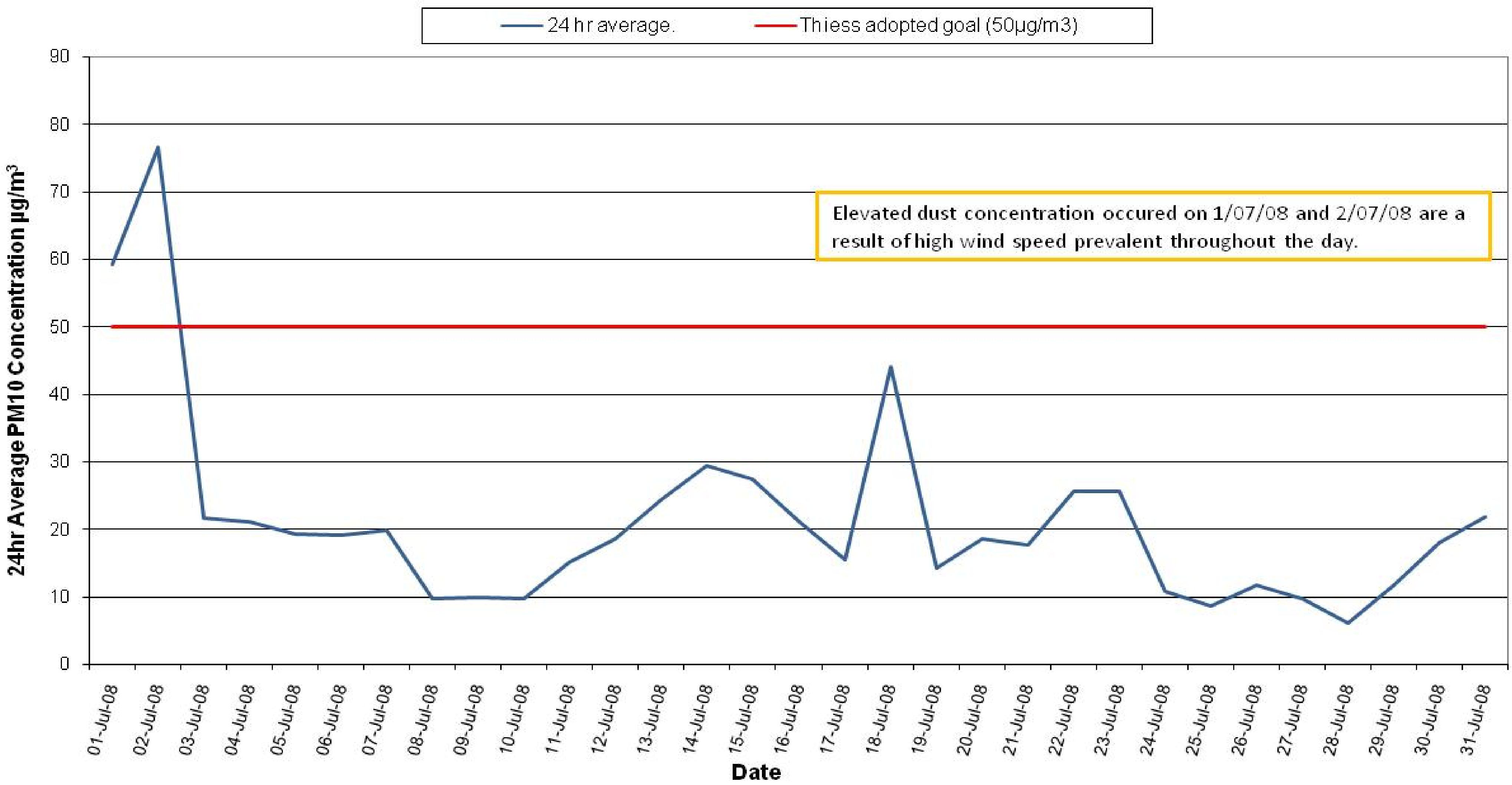


This graph illustrates the PM_{10} dust concentration measured at the residential receptor in Blaxland Road, Rhodes, for the period 1-30 November 2008. The blue line shows the average 24hr dust concentration measured in micrograms per metre cubed ($\mu g/m^3$) and the red line represents the Thiess Air Quality Goal of $50\mu g/m^3$. The goal (limit) is based on the $50\mu g/m^3$ standard specific in the *National Environment Protection Measure for Ambient Air Quality* (Air NEPM).



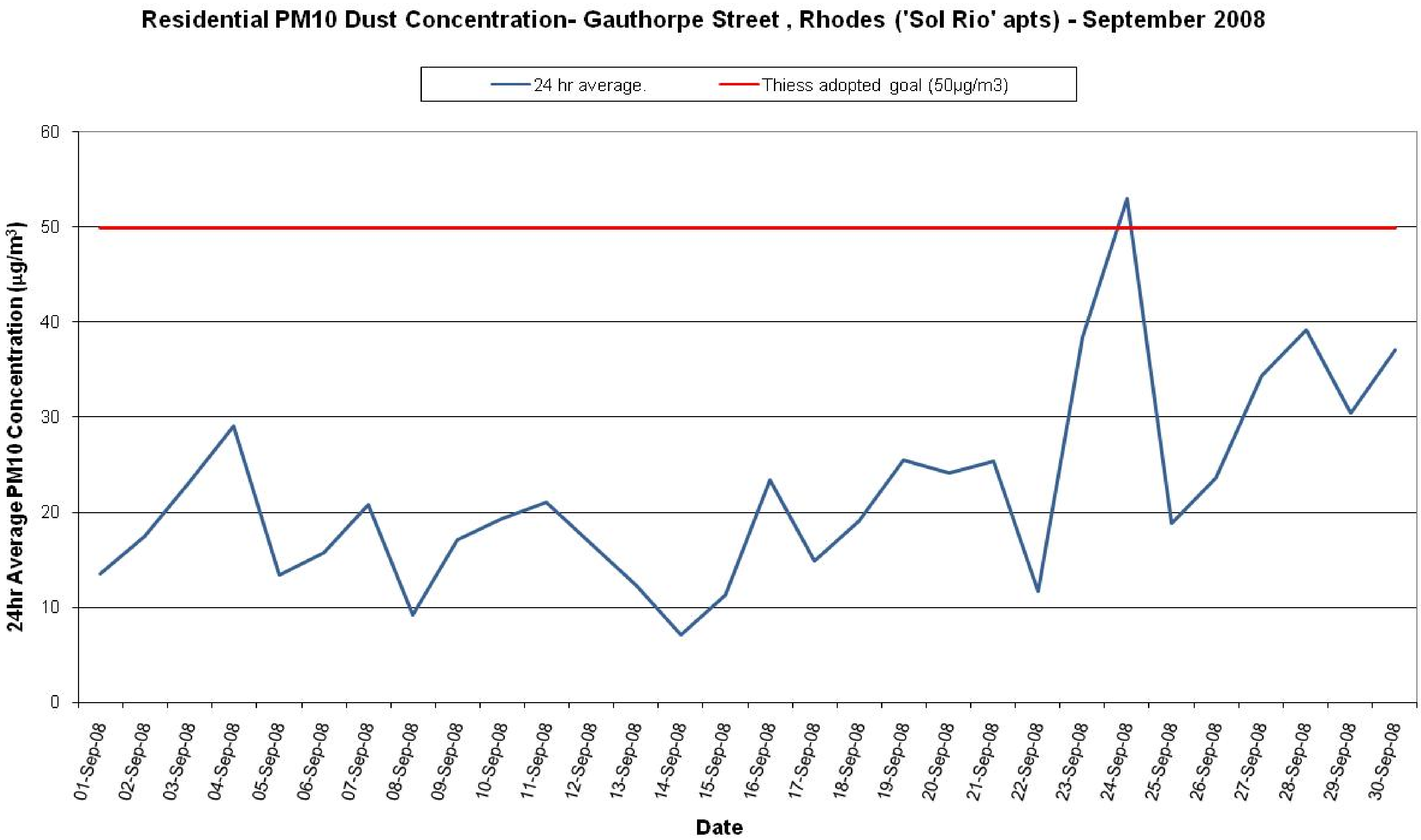
This graph illustrates the PM_{10} dust concentration measured at the residential receptor in Blaxland Road, Rhodes, for the period 1-31st December 2008. The blue line shows the average 24hr dust concentration measured in micrograms per metre cubed (µg/m^3) and the red line represents the Thiess Air Quality Goal of 50µg/m^3. The goal (limit) is based on the 50µg/m^3 standard specific in the *National Environment Protection Measure for Ambient Air Quality* (Air NEPM).

Residential PM_{10} Dust Concentration - Gauthorpe Street , Rhodes ('Sol Rio ' apts.) - July 2008

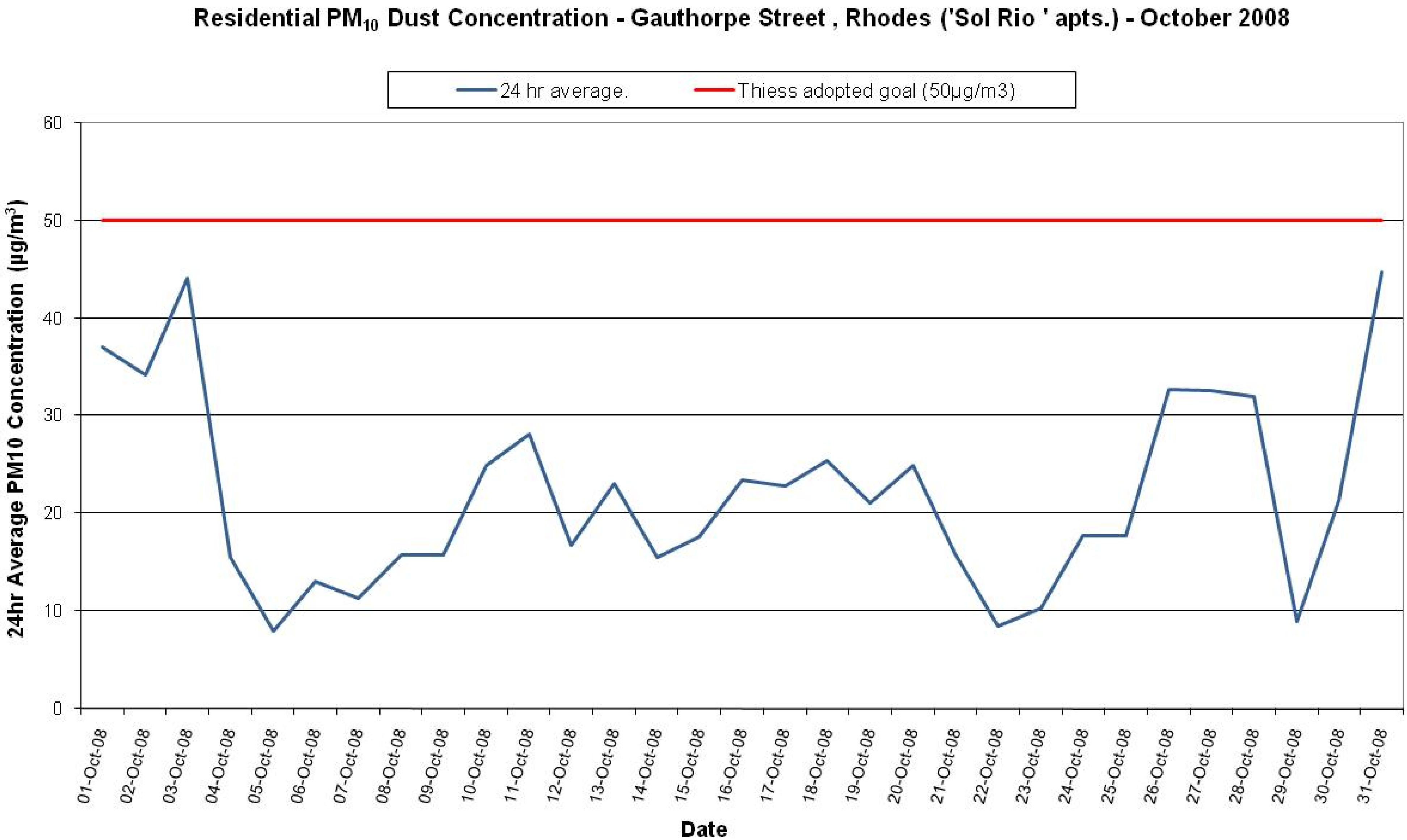


This graph illustrates the PM_{10} dust concentration measured at the residential receptor in Gauthorpe St, Rhodes (‘Sol Rio’ apartments), for the period 1-31 July 2008.

The blue line shows the average 24hr dust concentration (measured in $\mu g/m^3$) and the red line represents the Thiess Air Quality Goal of $50\mu g/m^3$.



This graph illustrates the PM_{10} dust concentration measured at the residential receptor in Gauthorpe St, Rhodes ('Sol Rio' apartments), for the period 1-30 September 2008. The blue line shows the average 24hr dust concentration measured in micrograms per metre cubed ($\mu g/m^3$) and the red line represents the Thiess Air Quality Goal of $50\mu g/m^3$.



This graph illustrates the PM_{10} dust concentration measured at the residential receptor in Gauthorpe St, Rhodes ('Sol Rio' apartments), for the period 1-31 October 2008. The blue line shows the average 24hr dust concentration measured in micrograms per metre cubed (µg/m^3) and the red line represents the Thiess Air Quality Goal of 50µg/m^3.

Appendix B

Particulate Matter Assessment for Residential occupation of Lot 100

Attachment 2 – Detailed Emissions Inventory

Emissions Inventory

Soil Removal / Excavation Activities

#	Site	Source Name	Source Abbreviation	Source Type	X (m)	Y (m)	Base Elevation	Release Height	Init. Horiz. Plume Spread	Init. Vertical Plume Spread	Emission Factors PM10	Emission Factors TSP	Emission Factors Units	Transfer Volumes Volume	Transfer Volumes Unit	Emission Rates PM10	Emission Rates TSP	Emission Rates Units	Source Description / Comments	Modelling Emission Rates PM10	Modelling Emission Rates TSP	Modelling Emission Rates Units
1	Allied Feeds / Meriton	Excavator 1	EX1	Volume	322986	6255569	9	2.5	4	2	0.00018	0.00038	kg/t	675	t/day	0.12	0.25	kg/day	Excavation of Lot 101	0.120	0.254	kg/hr
2		Excavator 2	EX2	Volume	322972	6255507	11	2.5	4	2	0.00018	0.00038	kg/t	675	t/day	0.12	0.25	kg/day	Excavation of Lot 102	0.120	0.254	kg/hr
														TOTAL EMISSIONS		0.24	0.51	kg/day				
3	Lednez	Excavator 3	EX3	Volume	322886	6255332	10	2.5	4	2	0.00018	0.00038	kg/t	1625	t/day	0.29	0.61	kg/day	Excavator operating in remediation area removing in-situ characterized material	0.289	0.610	kg/hr
4		Excavator 4	EX4	Volume	322681	6255376	1	2.5	4	2	0.00018	0.00038	kg/t	1250	t/day	0.22	0.47	kg/day	Excavator loading backfill material into the bay or receiving excavated sediment by barge	0.222	0.469	kg/hr
5		Excavator 5	EX5	Volume	322850	6255306	9	2.5	4	2	0.00018	0.00038	kg/t	2750	t/day	0.49	1.03	kg/day	Excavator emptying storage trenches and loading DTD treated material	0.488	1.033	kg/hr
														TOTAL EMISSIONS		1.00	2.11	kg/day				

Truck Haulage

#	Site	Source Name	Source Abbreviation	Source Type	X (m)	Y (m)	Base Elevation	Release Height	Initial Sigma Y	Initial Sigma Z	Emission Factors PM10	Emission Factors TSP	Emission Factors Units	Truck Movements	Haul Road Length		VKT Travelled	Control Factor	Emission Rates PM10	Emission Rates TSP	Emission Rates Units	Source Description / Comments	Modelling Emission Rates PM10	Modelling Emission Rates TSP	Modelling Emission Rates Units
6	Allied Feeds / Meriton	Haul Road 1	HR1a	Volume	323037	6255615	10	3	2.2	2.8	0.51	2.05	kg/VKT	130	0.01	km	1.3	90%	0.07	0.27	kg/day	Truck Haulage of excavated material from lots 101 and 102	0.007	0.030	kg/hr
7		Haul Road 1	HR1b	Volume	323027	6255618	10	3	2.2	2.8	0.51	2.05	kg/VKT	130	0.01	km	1.3	90%	0.07	0.27	kg/day		0.007	0.030	kg/hr
8		Haul Road 1	HR1c	Volume	323018	6255621	9	3	2.2	2.8	0.51	2.05	kg/VKT	130	0.01	km	1.3	90%	0.07	0.27	kg/day		0.007	0.030	kg/hr
9		Haul Road 1	HR1d	Volume	323008	6255625	9	3	2.2	2.8	0.51	2.05	kg/VKT	130	0.01	km	1.3	90%	0.07	0.27	kg/day		0.007	0.030	kg/hr
10		Haul Road 1	HR1e	Volume	322998	6255628	8	3	2.2	2.8	0.51	2.05	kg/VKT	130	0.01	km	1.3	90%	0.07	0.27	kg/day		0.007	0.030	kg/hr
11		Haul Road 1	HR1f	Volume	322989	6255631	8	3	2.2	2.8	0.51	2.05	kg/VKT	130	0.01	km	1.3	90%	0.07	0.27	kg/day		0.007	0.030	kg/hr
12		Haul Road 1	HR1g	Volume	322979	6255634	8	3	2.2	2.8	0.51	2.05	kg/VKT	130	0.01	km	1.3	90%	0.07	0.27	kg/day		0.007	0.030	kg/hr
13		Haul Road 1	HR1h	Volume	322969	6255638	7	3	2.2	2.8	0.51	2.05	kg/VKT	130	0.01	km	1.3	90%	0.07	0.27	kg/day		0.007	0.030	kg/hr
14		Haul Road 1	HR1i	Volume	322960	6255641	7	3	2.2	2.8	0.51	2.05	kg/VKT	130	0.01	km	1.3	90%	0.07	0.27	kg/day		0.007	0.030	kg/hr
15		Haul Road 1	HR1j	Volume	322950	6255644	6	3	2.2	2.8	0.51	2.05	kg/VKT	40	0.01	km	0.4	90%	0.02	0.08	kg/day		0.002	0.009	kg/hr
16		Haul Road 1	HR1k	Volume	322952	6255654	6	3	2.2	2.8	0.51	2.05	kg/VKT	40	0.01	km	0.4	90%	0.02	0.08	kg/day		0.002	0.009	kg/hr
17		Haul Road 1	HR1l	Volume	322954	6255664	6	3	2.2	2.8	0.51	2.05	kg/VKT	40	0.01	km	0.4	90%	0.02	0.08	kg/day		0.002	0.009	kg/hr
18		Haul Road 1	HR1m	Volume	322956	6255674	6	3	2.2	2.8	0.51	2.05	kg/VKT	40	0.01	km	0.4	90%	0.02	0.08	kg/day		0.002	0.009	kg/hr
19		Haul Road 1	HR1n	Volume	322958	6255684	6	3	2.2	2.8	0.51	2.05	kg/VKT	40	0.01	km	0.4	90%	0.02	0.08	kg/day		0.002	0.009	kg/hr
20		Haul Road 1	HR1o	Volume	322960	6255694	6	3	2.2	2.8	0.51	2.05	kg/VKT	40	0.01	km	0.4	90%	0.02	0.08	kg/day		0.002	0.009	kg/hr
21		Haul Road 1	HR1p	Volume	322953	6255701	5	3	2.2	2.8	0.51	2.05	kg/VKT	40	0.01	km	0.4	90%	0.02	0.08	kg/day		0.002	0.009	kg/hr
22		Haul Road 2	HR2a	Volume	322947	6255634	7	3	2.2	2.8	0.51	2.05	kg/VKT	90	0.01	km	0.9	90%	0.05	0.18	kg/day	Truck Haulage of materials to lot 103	0.005	0.021	kg/hr
23		Haul Road 2	HR2b	Volume	322944	6255624	7	3	2.2	2.8	0.51	2.05	kg/VKT	90	0.01	km	0.9	90%	0.05	0.18	kg/day		0.005	0.021	kg/hr
24		Haul Road 2	HR2c	Volume	322940	6255615	7	3	2.2	2.8	0.51	2.05	kg/VKT	90	0.01	km	0.9	90%	0.05	0.18	kg/day		0.005	0.021	kg/hr
25		Haul Road 2	HR2d	Volume	322937	6255605	7	3	2.2	2.8	0.51	2.05	kg/VKT	90	0.01	km	0.9	90%	0.05	0.18	kg/day		0.005	0.021	kg/hr
26		Haul Road 2	HR2e	Volume	322930	6255587	7	3	4.7	2.8	0.51	2.05	kg/VKT	90	0.02	km	1.8	90%	0.09	0.37	kg/day		0.010	0.041	kg/hr
27		Haul Road 2	HR2f	Volume	322922	6255568	8	3	4.7	2.8	0.51	2.05	kg/VKT	90	0.02	km	1.8	90%	0.09	0.37	kg/day		0.010	0.041	kg/hr
																	TOTAL EMISSIONS		1.10	4.46	kg/day				
28	Lednez	Haul Road 3 Start	HRS3	Volume	322852	6255531	6	3	4.7	2.8	0.51	2.05	kg/VKT	82	0.08	km	6.314	90%	0.32	1.30	kg/day	Truck haulage of clean VENM shale backfill	0.032	0.130	kg/hr
29		Haul Road 3 Mid	HRM3	Volume	322767	6255453	5	3	4.7	2.8	0.51	2.05	kg/VKT	82	0.08	km	6.314	90%	0.32	1.30	kg/day		0.032	0.130	kg/hr
29		Haul Road 3 End	HRE3	Volume	322681	6255376	3	3	4.7	2.8	0.51	2.05	kg/VKT	82	0.08	km	6.314	90%	0.32	1.30	kg/day		0.032	0.130	kg/hr
30		Haul Road 4 Start	HRS4	Volume	322893	6255381	11	3	4.7	2.8	0.51	2.05	kg/VKT	50	0.04	km	2.2	90%	0.11	0.45	kg/day	Truck haulage of material into the PTB	0.011	0.045	kg/hr
30		Haul Road 4 Mid	HRM4	Volume	322838	6255348	10	3	4.7	2.8	0.51	2.05	kg/VKT	50	0.04	km	2.2	90%	0.11	0.45	kg/day		0.011	0.045	kg/hr
31		Haul Road 4 End	HRE4	Volume	322782	6255314	8	3	4.7	2.8	0.51	2.05	kg/VKT	50	0.04	km	2.2	90%	0.11	0.45	kg/day		0.011	0.045	kg/hr
31		Haul Road 5 Start	HRS5	Volume	322782	6255314	8	3	4.7	2.8	0.51	2.05	kg/VKT	240	0.06	km	13.44	90%	0.68	2.76	kg/day	Truck Haulage to final backfill location	0.068	0.276	kg/hr
32		Haul Road 5 Mid	HRM5	Volume	322865	6255326	11	3	4.7	2.8	0.51	2.05	kg/VKT	240	0.06	km	13.44	90%	0.68	2.76	kg/day		0.068	0.276	kg/hr
32		Haul Road 5 End	HRE5	Volume	322947	6255338	14	3	4.7	2.8	0.51	2.05	kg/VKT	240	0.06	km	13.44	90%	0.68	2.76	kg/day		0.068	0.276	kg/hr
33		Haul Road 6 Start	HRS6	Volume	322815	6255261	11	3	4.7	2.8	0.51	2.05	kg/VKT	60	0.04	km	2.52	90%	0.13	0.52	kg/day	Transfer to and From Temporary Storage Cell	0.013	0.052	kg/hr
33		Haul Road 6 Mid	HRM6	Volume	322877	6255270	12	3	4.7	2.8	0.51	2.05	kg/VKT	60	0.04	km	2.52	90%	0.13	0.52	kg/day		0.013	0.052	kg/hr
34		Haul Road 6 End	HRE6	Volume	322938	6255279	14	3	4.7	2.8	0.51	2.05	kg/VKT	60	0.04	km	2.52	90%	0.13	0.52	kg/day		0.013	0.052	kg/hr
																	TOTAL EMISSIONS		3.71	15.08	kg/day				

Unloading / Loading Operations

#	Site	Source Name	Source Abbreviation	Source Type	X (m)	Y (m)	Base Elevation	Release Height	Init. Horiz. Plume Spread	Init. Vertical Plume Spread	Emission Factors PM10	Emission Factors TSP	Emission Factors Units	Transfer Volumes Volume	Transfer Volumes Units	Emission Rates PM10	Emission Rates TSP	Emission Rates Units	Source Description / Comments	Modelling Emission Rates PM10	Modelling Emission Rates TSP	Modelling Emission Rates Units
24	Lednez	Loading Shale VENM	TR1	Volume	322856	6255526	6	1.5	4	2	0.00018	0.00038	kg/T	1250	t/day	0.22	0.47	kg/day	Transfer of shale to trucks @ shale storage pile	0.022	0.047	kg/hr
25		Unloading @ PTB	TR2	Volume	322800	6255350	6	1.5	4	2	0.00018	0.00038	kg/T	1250	t/day	0.22	0.47	kg/day	Unloading material @ PTB / storage cell	0.022	0.047	kg/hr
26		Unloading @ Backfill Area	TR3	Volume	322946	6255334	12	1.5	4	2	0.00018	0.00038	kg/T	1250	t/day	0.22	0.47	kg/day	Unloading of treated material @ backfill area	0.022	0.047	kg/hr
27		FEL Operating in Cell	TR4	Volume	322903	6255310	11	1	4	2	0.00018	0.00038	kg/t	1250	t/day	0.22	0.47	kg/day	FEL operating in Cell	0.022	0.047	kg/hr
28		FEL Operating in Cell	TR5	Volume	322901	6255254	13	1	4	2	0.00018	0.00038	kg/t	1250	t/day	0.22	0.47	kg/day	FEL Operating in Cell	0.022	0.047	kg/hr
														TOTAL EMISSIONS		1.11	2.35	kg/day				

Wind Erosion

#	Site	Source Name	Source Abbreviation	Source Type	X (m)	Y (m)	Base Elevation	Release Height	Init. Horiz. Plume Spread	Init. Vertical Plume Spread	Emission Factors PM10	Emission Factors TSP	Emission Factors Units	Assumed Stock Pile Area (ha)	Emission Rates PM10	Emission Rates TSP	Emission Rates Units	Source Description / Comments	Modelling Emission Rates PM10	Modelling Emission Rates TSP	Modelling Emission Rates Units
29	Allied Feeds / Meriton	Exposed Areas	EA 1	Volume	322879	6255609	4	1	10	10	0.2	0.4	kg/ha/hr	0.0625	0.01	0.03	kg/hr	Wind Erosion from exposed areas, namely Lot 104	0.013	0.025	kg/hr
														TOTAL EMISSIONS	0.01	0.03	kg/hr				
30	Lednez	DTD Treated Material	SP1	Volume	322663	6255213	3	2.5	5	1	0.2	0.4	kg/ha/hr	0.20808	0.04	0.08	kg/hr	Wind Erosion from DTD treated material stockpile	0.042	0.083	kg/hr
31		VENM Shale StockPile	SP2	Volume	322856	6255526	6	2.5	5	1	0.2	0.4	kg/ha/hr	0.270504	0.05	0.11	kg/hr	Wind Erosions from VENM Shale backfill stockpile	0.054	0.108	kg/hr
														TOTAL EMISSIONS	0.10	0.19	kg/hr				

Stack Sources

#	Site	Source Name	Source Abbreviation	Source Type	X (m)	Y (m)	Base Elevation	Stack Diameter	Exit Velocity	Exit Temp. (K)	Emission Rates PM10	Emission Rates TSP	Emission Rates Units	Source Description / Comments	Modelling Emission Rates PM10	Modelling Emission Rates TSP	Modelling Emission Rates Units
31	Lednez	PTB Stack	LPTB	Point	322806	6255293	8	1	8.6	300	0.03	NA	g/s	Particulate Matter from Lednez PTB stack considered as PM10	0.032	NA	g/s
32		DTD Stack	LDTD	Point	322760	6255350	8	1.2	10.4	352	0.18	NA	g/s	Particulate Matter from Lednez DTD stack considered as PM10	0.184	NA	g/s
										TOTAL EMISSIONS	0.22		g/s				

Appendix C Stack Emission Analysis

C. Stack Emission Analysis

Appendix C Stack Emission Analysis

A stack modelling assessment has been performed as part of the consideration of the potential health risk impacts at Lot 100. This Appendix provides background to the methodology used to calculate the impacts of stack pollutant discharges from the soil remediation plant located on the Lednez site.

Stack pollutant impacts have been assessed through dispersion modelling, based on available pollutant discharge emission rates and stack emission parameters. Stack emissions from the Allied Feeds remediation activities have not been included on the basis that thermal treatment on the site will be decommissioned prior to residential occupation at Lot 100.

1.1 Emissions Sources

The Lednez stack sources considered are detailed below:

- Pre-Treatment Building (PTB) Stack: Excavated soil unloading, screening, crushing, sorting and pre-treatment activities occur within the Pre-treatment building which is fitted with an emission control system, whereby air is extracted from the building and passes through granular activated carbon filter before ventilation to atmosphere via a stack.
- Direct Thermal Desorption Unit (DTD): Contaminated material passes through feed handling, a rotary dryer, gas treatment, treatment, treated soil handling and water treatment processes with emissions released to air (following emission control measures comprising a continuously operated thermal oxidiser) via a stack.

1.1.1 Stack Emission Data

A review of investigations conducted at the Allied Feeds and adjacent Lednez sites has been undertaken to determine relevant stack parameters and emission rates for direct input into the modelling stage of the assessment.

To date, there exist various sources of emission data for the treatment plants on the Rhodes peninsula. Previous air quality assessments on the site performed prior to commissioning of the Allied Feeds Direct Thermal Desorption plant (DTD) and Pre-Treatment Building (PTB) have sourced emission rates from a similar style of plant operating in the United States. Since the time of the EIS, actual stack data has become available for the Allied Feeds and Lednez sites, and these data (as presented in relevant Proof of Performance (PoP) reports) have been used as the primary source of data. For this assessment the following sources of data were also utilised for the evaluation of stack emissions from the Lednez site:

1. **Allied Feeds DTD Proof of Performance (PoP) Reports:**
   - HLA Envirosciences Pty Ltd (2007), *Emission Testing Report – Former Allied Feeds Site Homebush March 2007*, April 2007; and
   - HLA Envirosciences Pty Ltd (2007), *Emission Testing Report – Former Allied Feeds Site Homebush May 2007,* June 2007.
   - Airlabs Environmental (2008), Test Report No. JAN08009, *Dioxin & Furan Monitoring Conducted on the Thiess Services Direct Thermal Desorption Plant in Rhodes, Date of Testing: 18th January, 2008,* January 2008.
   - Airlabs Environmental (2008), Test Report No. MAR08039, *Monitoring Conducted on the DTD Stack for Thiess Services in Rhodes, Date of Testing: 18th & 19th March, 2008,* April 2008.

- Airlabs Environmental (2008), Test Report No. APR08047, *Dioxin & Furan Monitoring Conducted on the Thiess Services Direct Thermal Desorption Plant in Rhodes, Date of Testing: 2nd April, 2008,* May 2008.
- Airlabs Environmental (2008), Test Report No. JUN08077, *Monitoring Conducted on the DTD Stack for Thiess Services in Rhodes, Date of Testing: 17th & 18th June, 2008,* July 2008.
- Airlabs Environmental (2008), Test Report No. JUL080104A, *Dioxin & Furan Monitoring Conducted on the Thiess Services Direct Thermal Desorption Plant in Rhodes, Analysis Separation Report, Date of Testing: 31st July, 2008,* August 2008.
- Airlabs Environmental (2008), Test Report No. AUG08117, *Dioxin & Furan Monitoring Conducted on the Thiess Services Direct Thermal Desorption Plant in Rhodes, Date of Testing: 21st August, 2008,* September 2008.
- Airlabs Environmental (2008), Test Report No. MAY08066, *Dioxin & Furan Monitoring Conducted on the Thiess Services Direct Thermal Desorption Plant in Rhodes, Analysis Separation Report, Date of Testing: 29th May, 2008,* October 2008.
- Airlabs Environmental (2008), Test Report No. SEP0812127, *Monitoring Conducted on the DTD Stack for Thiess Services in Rhodes, Date of Testing: 10th & 17th September, 2008,* October 2008.

2. Lednez DTD Proof of Performance (PoP) Report:

- Airlabs Environmental (2008), Test Report No. OCT08159, *Monitoring Conducted on the DTD Stack for Thiess Services in Rhodes, Date of Testing: 14th & 20th November, 2008,* December 2008

3. PTB Proof of Performance (PoP) Reports:

- HLA Envirosciences Pty Ltd (2007), *Emission Testing Report – Allied Feeds Site August 2007,* November 2007; and
- Airlabs Environmental (2008), *Monitoring conducted on the ECS Stack for Thiess Services in Rhodes*, April 2008.
- Airlabs Environmental (2008), Test Report No. MAR08039A, *Monitoring Conducted on the ECS Stack for Thiess Services in Rhodes, Date of Testing: 1st -2nd April, 2008,* April 2008.
- Airlabs Environmental (2008), Test Report No. OCT08160, *Monitoring Conducted on the ECS Stack for Thiess Services in Rhodes, Date of Testing: 30th and 31st October, 2008,* December 2008.

4. Air Quality Management Plan Data (DTD):

- Thiess Services Pty Ltd (2005), *Remediation of the Former Allied Feeds Site - Air Quality Management Plan,* April 2005.

5. Environmental Impact Statement Data (PTB):

- Parsons Brinckerhoff (2002), *Remediation of Lednez Site, Rhodes and Homebush Bay Environmental Impact Statement*, December 2002.

Appendix C Stack Emission Analysis

The chemical species identified as part of the PoP reports are detailed in **Table C1**.

Table C1: Chemical Species Included in Proof of Performance Testing Data

DTD Testing	PTB Testing
Total Solid Particulates	Total Solid Particulates
Sulphuric Acid Mist	Hazardous Substances (Metals)
Hydrogen Chloride and Chlorine	Volatile Organic Compounds (Aug 07 only)
Total Fluoride	Dioxins and Furans
Hazardous Substances (Metals)	
Oxides of Nitrogen	
Carbon Monoxide	
Volatile Organic Compounds	
Dioxins and Furans	
PAHs (Lednez PoP only)	
Hexachlorobenzene (Lednez PoP only)	

In this assessment, all provided PoP stack testing data reports (listed above) were reviewed and compared. The maximum measured emission rates for each type of plant (DTD and PTB) were noted and applied to the dispersion modelling stage of the assessment. It should be noted that although a given maximum emission rate may have resulted from testing of the Allied Feeds facility, it has been considered relevant and appropriate for application to the Lednez facility as these two sites are treating soils that have been exposed to similar levels and types of contaminants, in plants of a similar design. For species where no stack testing has been performed (e.g. various chlorinated hydrocarbons) the Allied Feeds EIS and Lednez Air Quality Management Plan data have been used.

Table C2 below provides a summary of the emission rates used in the atmospheric dispersion modelling, representing the maximum measured emission rate from the data sources in Section 1.2.1.

Table C2: Summary of Emission Rates

Substance	Emission Rate DTD g/s	Emission Rate PTB g/s	Data Source
Antimony	1.85×10^{-4}	1.71×10^{-4}	1,2
Arsenic	1.38×10^{-4}	1.29×10^{-4}	1,2
Beryllium	8.33×10^{-7}	1.00×10^{-6}	1,2
Cadmium	1.60×10^{-5}	6.80×10^{-6}	1,2
Chromium	4.00×10^{-5}	1.65×10^{-5}	1,2
Cobalt	1.44×10^{-5}	2.30×10^{-6}	1,2
Copper	5.36×10^{-5}	3.40×10^{-6}	1,2
Manganese	4.33×10^{-4}	1.58×10^{-4}	1,2
Mercury	2.28×10^{-4}	1.67×10^{-6}	1,2
Nickel	9.33×10^{-4}	2.83×10^{-4}	1,2
Lead	1.12×10^{-5}	5.00×10^{-6}	1,2
Selenium	1.32×10^{-5}	1.00×10^{-6}	1,2
Tin	1.00×10^{-4}	3.67×10^{-5}	1,2
Vanadium	1.67×10^{-6}	2.00×10^{-6}	1,2
Thallium	6.95×10^{-5}	1.47×10^{-5}	1,2
Acetone	1.46×10^{-2}	1.08×10^{-3}	1,2
Chloroform	2.14×10^{-3}	1.08×10^{-3}	1,2
Benzene	1.64×10^{-2}	1.08×10^{-3}	1,2
Toluene	1.35×10^{-1}	2.18×10^{-3}	1,2
Chlorobenzene	2.14×10^{-3}	3.07×10^{-2}	1,2
Ethylbenzene	2.14×10^{-3}	1.08×10^{-3}	1,2
m- & p-Xylene	4.29×10^{-3}	3.92×10^{-3}	1,2
o-Xylene	2.14×10^{-3}	1.53×10^{-3}	1,2
Isopropylbenzene	2.14×10^{-3}	1.08×10^{-3}	1,2
1,3,5-Trimethylbenzene	2.14×10^{-3}	1.08×10^{-3}	1,2
1,2,4-Trimethylbenzene	2.14×10^{-3}	1.08×10^{-3}	1,2
1,3-Dichlorobenzene	2.14×10^{-3}	1.08×10^{-3}	1,2
1,4-Dichlorobenzene	2.14×10^{-3}	1.85×10^{-2}	1
1,2-Dichlorobenzene	2.14×10^{-3}	1.08×10^{-3}	1
Hexachlorobutadiene	2.14×10^{-3}	1.08×10^{-3}	1
Total Suspended Particulate	1.84×10^{-1}	3.16×10^{-2}	1
Hydrogen Chloride	5.00×10^{-2}	NA	1
Chlorine	4.83×10^{-2}	NA	1
Dioxins (TEQ)	1.83×10^{-9}	1.02×10^{-10}	1
Total Fluoride	8.33×10^{-3}	NA	1
Sulfuric Acid Mist	1.41×10^{-1}	NA	3
Oxides of Nitrogen	4.5×10^{-0}	NA	3
Carbon Monoxide	7.00×10^{-2}	NA	4

PAH's	1.53×10^{-3}	NA	4
PCB's (vapour)	2.82×10^{-8}	NA	4
Dichloromethane	6.30×10^{-9}	NA	4
Dibromoethane	2.16×10^{-8}	NA	4
Benzo(a)Pyrene (dustborne)	NA	9.52×10^{-10}	4
DDD (dustborne)	NA	2.94×10^{-8}	4
Dieldrin (dustborne)	NA	4.36×10^{-10}	4
PCB's (dustborne)	NA	3.00×10^{-8}	4
2-Chlorophenol	NA	2.39×10^{-7}	4
Tetrachlorobenzene	NA	1.19×10^{-5}	4
1,2,3,4-Tetrachlorobenzene (dustborne)	NA	1.87×10^{-7}	4
1,2,3,5-Tetrachlorobenzene (dustborne)	NA	1.06×10^{-7}	4
Pentachlorobenzene	NA	5.98×10^{-7}	4
Hexachlorobenzene (vapour)	NA	1.13×10^{-7}	3
Hexachlorobenzene (dustborne)	NA	4.96×10^{-9}	3
Naphthalene (vapour)	NA	2.36×10^{-5}	3
Naphthalene (dustborne)	NA	3.94×10^{-8}	3

Notes:
NA: Not Assessed
1: DTD PoP Stack Testing Data
2: PTB PoP Stack Testing Data
3: Allied Feeds EIS
4: Lednez Air Quality Management Plan

1.1.2 Stack Emission Characteristics

Approximate stack locations and geometries for the Lednez treatment plant have been derived from data provided by Holmes Air Sciences (HAS)[1], in conjunction with aerial and site photographs. Exit velocities and temperatures have been derived from the PoP stack testing reports, as discussed in **Section 1.1.1**. As an additional conservative measure, the minimum exit velocities and temperatures have been used. A summary of stack emission parameters has been provided in **Table C3**.

Table C3: Stack Locations and Parameters

Stack Parameter	Units	Lednez	
		DTD	PTB
Stack Location	m (MGA94)	322760, 6255350	322806, 6255293
Height (above ground)	m	30	23
Diameter	m	1.2	1.0
Exit Temperature	°C	78	26
Exit Velocity	m/s	10.4	8.6

Figure C1 overleaf shows the location of the stacks considered in the assessment relative to the receptors (as marked by red triangles) located at Lot 100.

[1] Holmes Air Sciences (2006) *Summary of Modelling for Modified Lednez Proposal* August, 2006

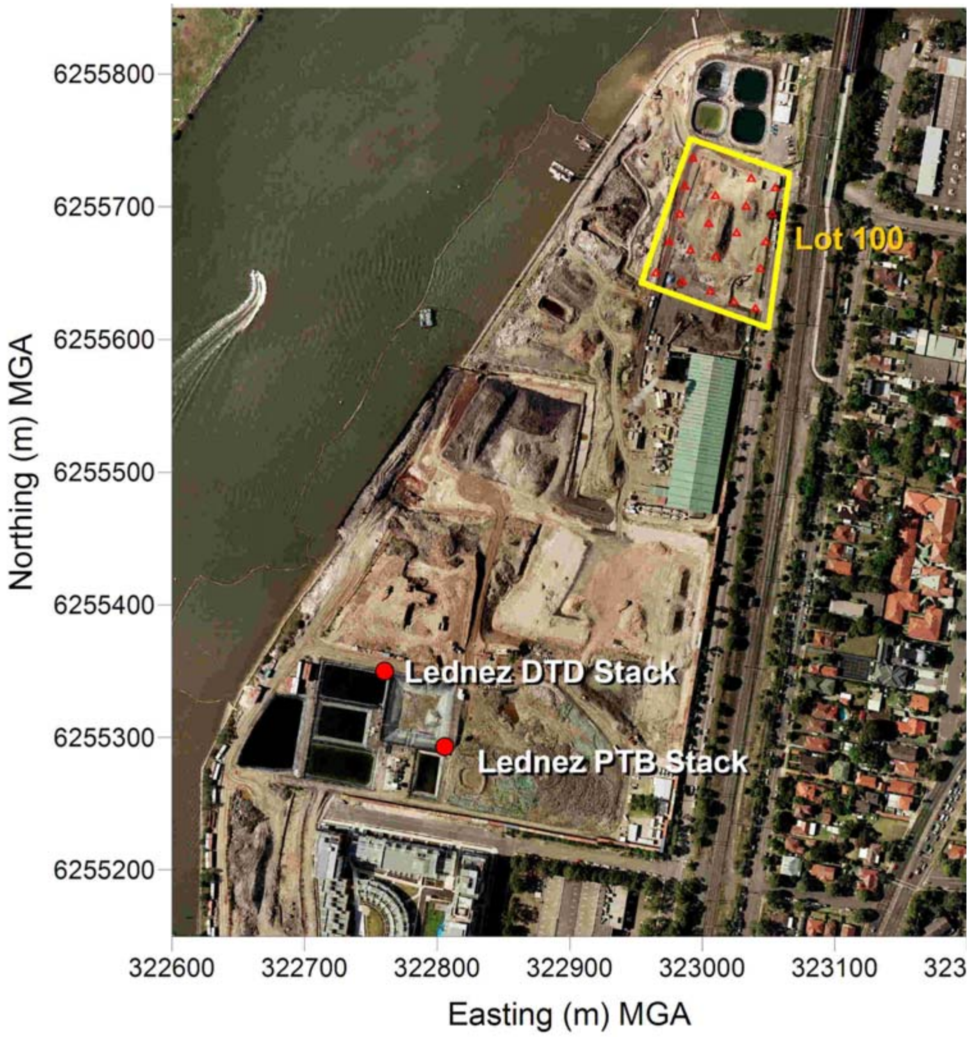


Figure C1: Aerial Photo Showing Lednez Stack Locations and Lot 100 Receptors

1.2 Atmospheric Dispersion Modelling

Stack contributions included in this risk assessment have been derived through atmospheric dispersion modelling, using the DECC approved dispersion model CALPUFF. The modelling has considered emissions from the following sources:

- Lednez Direct Thermal Desorption (DTD) stack; and
- Lednez Pre-Treatment Building (PTB) stack.

1.2.1 Dispersion Meteorology

The computer modelling programs TAPM and CALMET have been used in conjunction with onsite meteorological data, to compile a three dimensional meteorological model of the Rhodes peninsula. Modelled wind flow regimes were directly used for determining predicted pollutant concentrations at Lot 100. Details regarding the models and the parameters used can be found in **Appendix A**. The meteorological models are also consistent with those utilised within the Particulate Matter Assessment (**Appendix B**).

1.2.2 Receptor Locations

Ambient concentrations were evaluated at a total of 20 locations across Lot 100. For each of the 20 discrete receptor locations shown in Figure 1 , model predictions were calculated at ground level, as well as 1m, 9m, 17m, 25m, and 33m elevation. This was performed in order to estimate concentrations across the vertical extent of proposed residential locations.

1.2.3 Building Downwash

A building or structure is considered sufficiently close enough to a stack to cause plume downwash effects when the distance between the stack and the nearest part of the building is less than five times the lesser of the height or projected width of the building, and the height of the building is greater than 0.4 times the stack height.

The utility program BPIP (Building Profile Input Program) was used to establish wind direction specific building dimensions for each stack. The Lednez Pre-Treatment Building and stack locations were entered into BPIP, and the BPIP model outputs were used in dispersion modelling.

1.2.4 CALPUFF

The US EPA and NSW EPA accepted modelling package CALPUFF has been utilised for predicting stack pollutant impacts associated at Lot 100. CALPUFF is a non-steady state Gaussian puff dispersion model. The CALPUFF program is able to account for spatial variability of meteorological conditions, causality effects, low wind speed dispersion (during ‘calm’ conditions), and dispersion effects over a variety of spatially varying land surfaces. The stack dispersion modelling conducted in CALPUFF utilised the following parameters:

- No chemical transformation,
- ISC Urban wind speed profile exponents considered;
- Gradual plume rise and stack-tip downwash options enabled;
- Dispersion coefficients using turbulence-based micro-meteorology utilised;

- Partial plume path adjustment utilised for considering terrain effects; and
- Source emission rates and options as discussed within the emission inventory and throughout this report.

Model input parameters remained consistent with those utilised within the Particulate Matter assessment (**Appendix B**).

1.3 Dispersion Modelling Results

Table C4 provides a summary of the peak 1 hr, and annual average concentrations for all pollutants considered. These concentrations represent those predicted at the most affected receptor on Lot 100.

Table C4: Peak 1 hr, and Annual Average Concentrations

Substance	Peak Concentration	
	1hr Average µg/m³	Annual Average µg/m³
Antimony	6.27×10^{-2}	6.30×10^{-4}
Arsenic	4.73×10^{-2}	4.74×10^{-4}
Beryllium	3.67×10^{-4}	3.60×10^{-6}
Cadmium	2.50×10^{-3}	3.10×10^{-5}
Chromium	6.06×10^{-3}	7.59×10^{-5}
Cobalt	8.45×10^{-4}	1.66×10^{-5}
Copper	2.57×10^{-3}	4.66×10^{-5}
Manganese	5.81×10^{-2}	7.62×10^{-4}
Mercury	1.09×10^{-2}	1.61×10^{-4}
Nickel	1.04×10^{-1}	1.47×10^{-3}
Lead	5.31×10^{-4}	4.80×10^{-5}
Selenium	6.26×10^{-4}	1.19×10^{-5}
Tin	4.76×10^{-3}	3.56×10^{-4}
Vanadium	7.93×10^{-5}	1.86×10^{-5}
Thallium	5.40×10^{-3}	9.06×10^{-5}
Acetone	7.01×10^{-1}	1.31×10^{-2}
Chloroform	3.99×10^{-1}	4.66×10^{-3}
Benzene	7.86×10^{-1}	1.44×10^{-2}
Toluene	6.42×10^{0}	9.84×10^{-2}
Chlorobenzene	1.13×10^{1}	1.04×10^{-1}
Ethylbenzene	3.99×10^{-1}	4.66×10^{-3}
m- & p-Xylene	1.44×10^{0}	1.45×10^{-2}
o-Xylene	5.61×10^{-1}	5.96×10^{-3}
Isopropylbenzene	3.99×10^{-1}	4.66×10^{-3}
1,3,5-Trimethylbenzene	3.99×10^{-1}	4.66×10^{-3}
1,2,4-Trimethylbenzene	3.99×10^{-1}	4.66×10^{-3}
1,3-Dichlorobenzene	3.99×10^{-1}	4.66×10^{-3}
1,4-Dichlorobenzene	3.99×10^{-1}	4.66×10^{-3}
1,2-Dichlorobenzene	3.99×10^{-1}	4.66×10^{-3}
Hexachlorobutadiene	3.99×10^{-1}	4.66×10^{-3}
Total Suspended Particulate	1.16×10^{1}	2.18×10^{-1}
Hydrogen Chloride	2.38×10^{0}	3.42×10^{-2}
Chlorine	2.30×10^{0}	3.30×10^{-2}

Appendix C Stack Emission Analysis

Substance	Peak Concentration	
	1hr Average µg/m³	Annual Average µg/m³
Dioxins (TEQ)	8.78×10^{-8}	1.55×10^{-9}
Total Fluoride	3.96×10^{-1}	5.69×10^{-3}
Sulfuric Acid Mist	6.71×10^{0}	9.64×10^{-2}
Oxides of Nitrogen	2.14×10^{1}	3.07×10^{0}
Carbon Monoxide	3.33×10^{0}	4.78×10^{-2}
PAH's	7.29×10^{-5}	1.05×10^{-6}
PCB's (vapour)	1.34×10^{-6}	1.93×10^{-8}
Dichloromethane	3.00×10^{-7}	4.30×10^{-9}
Dibromoethane	1.03×10^{-6}	1.48×10^{-8}
Benzo(a)Pyrene (dustborne)	3.50×10^{-7}	3.21×10^{-9}
DDD (dustborne)	1.08×10^{-5}	9.91×10^{-8}
Dieldrin (dustborne)	1.60×10^{-7}	1.47×10^{-9}
PCB's (dustborne)	1.10×10^{-5}	1.01×10^{-7}
2-Chlorophenol	8.78×10^{-5}	8.06×10^{-7}
Tetrachlorobenzene	4.37×10^{-3}	4.01×10^{-5}
1,2,3,4-Tetrachlorobenzene (dustborne)	4.37×10^{-3}	4.01×10^{-5}
1,2,3,5-Tetrachlorobenzene (dustborne)	4.37×10^{-3}	4.01×10^{-5}
Pentachlorobenzene	2.20×10^{-4}	2.02×10^{-6}
Hexachlorobenzene (vapour)	4.15×10^{-5}	3.81×10^{-7}
Hexachlorobenzene (dustborne)	1.66×10^{-4}	2.41×10^{-6}
Naphthalene (vapour)	8.67×10^{-3}	7.96×10^{-5}
Naphthalene (dustborne)	1.45×10^{-5}	1.33×10^{-7}

Appendix D VOC Monitoring Analysis

Appendix D VOC Monitoring Analysis

1.1 Summary

Ambient VOC monitoring performed by Parsons Brinkerhoff (P/L) on behalf of Thiess (P/L) as part of the environmental monitoring program for the Lednez Site, has been evaluated for its applicability for use in further analysis at Lot 100. Specifically, these data have been incorporated to the Human Health Risk Assessment (HHRA) for Lot 100 at the request of the NSW DECC (Department of Environment and Climate Change), to provide site-specific data to support the health risk assessment methodology.

URS have been provided with a spreadsheet of ambient VOC sampling undertaken between September 2007 and November 2008 (inclusive). The data contained in the spreadsheet includes monitoring details such as location, site operations at the time of sampling, sample collection start and stop times, as well as speciated VOC concentrations. URS understand that the Summa canister analysis was performed by SGS Australia Pty Ltd in Alexandria, who are NATA accredited for the US EPA TO-15 analytical method (which includes the analytical species contained in US EPA TO-14). The monitoring data have not been provided in a report form, and URS have not performed any data validation of the chemical analysis for this sampling, assessment of the sampling method, nor have been provided with documentation of laboratory analyses.

These data have been incorporated into the HHRA as follows:

- VOC monitoring has been assumed to represent ambient concentrations resulting from all emissions on the Lednez site, excluding stack sources, which were modelled separately (see **Appendix C** for details on stack modelling);
- A representation of annual average non-stack VOC concentrations at Lot 100 has been calculated by averaging all 24-hour summa canister monitoring data. Only analytes that were detected above the Limit of Reporting (LOR) in any one of the 26 samples were included in the average; and
- A representation of peak 1 hour average non-stack VOC concentrations at Lot 100 has been calculated using the peak results for each of analyte in all of the 8-hour and 24-hour summa canister monitoring. Worst case peak-to-mean ratios of 8 and 24 were used to adapt the 8-hour and 24-hour (respectively) sampling results in order to represent 1-hour concentrations. For example, 1ppm of toluene collected using an 8 hour summa canister would be assumed in this investigation, to result in an peak 1 hour average concentration of 8 ppm. Only analytes that were detected above the LOR in any one of the 55 samples were included.

The VOC data incorporated into the HHRA were required to be representative of exposures at Lot 100. On the basis of proximity, the application of Lednez boundary monitoring data to Lot 100 is considered conservative. In order to ensure this was so, dispersion modelling was performed for a 15 month period when the sampling was undertaken. This modelling was performed for a range of source areas on the site, and indicated that the adoption of Lednez boundary monitoring data at Lot 100 is conservative. In addition, it should also be noted that the VOC data were collected during a period when remediation works were also occurring at the Allied Feeds site, the effect of which, has conservative implications.

Details of the monitoring program, monitoring results, and dispersion model validation are contained in this Appendix.

1.2 VOC Monitoring

1.2.1 Monitoring Program

URS understands that at present, the Lednez VOC (Summa Canister) monitoring program consists of:

- Speciated VOC sampling using SUMMA canisters The US EPA Method TO-14 list of species was measured according to the US EPA Method TO-15 analysis method. Monitoring was undertaken monthly on the southern or eastern boundary for both 8-hour and 24-hour durations.
- Speciated VOC monitoring using SUMMA canisters is also undertaken on a fortnightly basis, alternating between a single 8-hour sample and a concurrent 8-hour / 24-hour sample, at the following locations:
  - On the southern boundary when no odorous works are undertaken (S1);
  - On the Southern Boundary (S1) and the Eastern Boundary (E1) when excavation works recommence or material is being handled in the cell;
  - On the Southern Boundary in front of the Statewide development (S2) when material is excavated from Area R3;
- Speciated VOC sampling using SUMMA canisters has also been undertaken in the Statewide Apartments (S3).

Figure 1-1 shows the sampling locations relative to the Lednez Site and Lot 100.

Figure 1-1 Location of VOC Monitoring Sites Relative to the Lednez Site and Lot 100

1.2.2 Monitoring Results

The monitoring data includes a number of samples that were collected between September 2007 and November 2008. **Table 1.1** shows the number of samples collected at each location and **Table 1-2** includes the processed results of the VOC monitoring.

Table 1-1 Number of Samples Collected

Sampling Location	Number of Samples	
	8hr	24hr
E1	4	4
S1	21	15
S2	3	3
S3	3*	4
TOTAL	31*	26

* Includes two five hour samples

Table 1-2 VOC Monitoring Results

Analyte	Results Across All Monitoring Sites		
	24hr Samples: Average (ppbv)	24hr Samples: Maximum (ppbv)	8hr Samples: Maximum (ppbv)
Dichlorodifluoromethane	0.71	0.9	1.0
Chloromethane	0.42	0.8	0.7
Bromomethane	0.46	1.3	0.4
Methylene chloride	10.44	88	60
Chloroform	0.46	1.3	0.4
Benzene	0.51	1.5	4.3
Toluene	1.78	3.8	3.8
Chlorobenzene	0.91	5.3	25
Ethylbenzene	0.43	0.9	0.8
m-& p-Xylene	1.07	2.2	2.7
o-Xylene	0.50	1	1.2
Styrene	0.42	0.6	0.4
1,3,5-Trimethylbenzene	0.41	0.5	1.2
1,2,4-Trimethylbenzene	0.55	0.9	1.8
1,3-Dichlorobenzene	0.54	5.2	2.3
1,4-Dichlorobenzene	2.02	12	38
1,2-Dichlorobenzene	1.35	6.4	26
1,2,4-Trichlorobenzene	5.16	30	100

1.2.3 Comparison against ambient levels

In order to provide some context to the monitoring data, a comparison against ambient monitoring performed by the NSW DEC was undertaken. The *Ambient Air Quality Research Project (1996-2001) – Internal working paper no. 2 – Ambient concentrations of toxic organic compounds* (DEC, 2004) contains details of 276 VOC samples taken at Rozelle in Sydney's inner west between 1996 and 2001, which are considered typical of urban air. In a manner similar to the Rhodes monitoring, the DEC (2004) sampling also used the US EPA TO-14 analytical method, with samples being collected in canisters over 24-hour periods. It should be noted that the limits of detection in DEC (2004) ranged from 0.1-0.2 ppbv, whereas the majority of the Rhodes monitoring has used a limit of detection of 0.4 ppbv (with some higher on occasion). Compounds that were never detected in Rozelle have been shown at their detection limit of 0.1 ppbv.

Figures 1-2,1-3 present a comparison of the averages and maxima of the 26 24-hour samples, and the 276 24-hour samples collected at the Rhodes and Rozelle sites (respectively).

The figures show that for a range of compounds, significantly higher ambient concentrations were recorded at Rhodes, as compared to those reported at Rozelle DEC (2004). These compounds include Methylene Chloride, Chlorobenzene, Dichlorobenzenes, and 1,2,4-Trichlorobenzene.

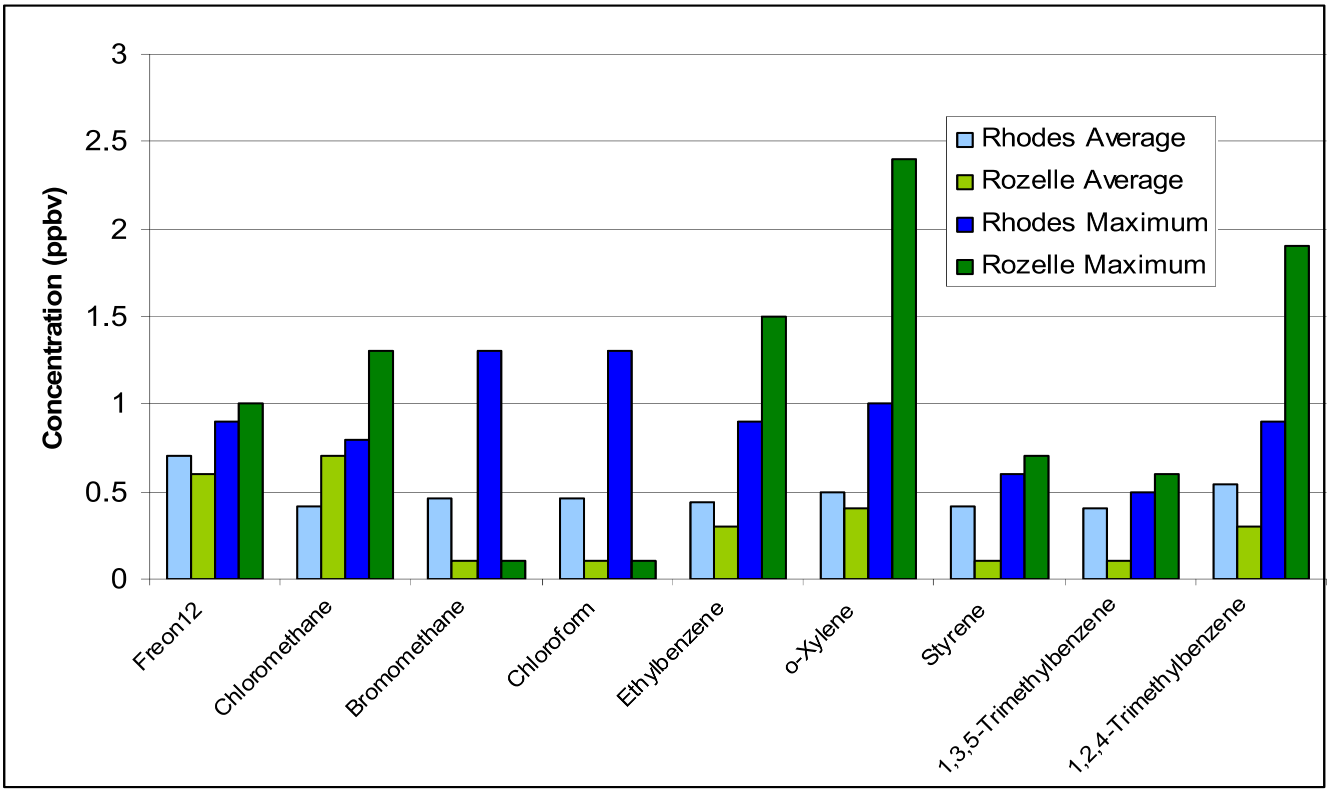


Figure 1-2 Comparison of Rhodes and Rozelle VOC Monitoring

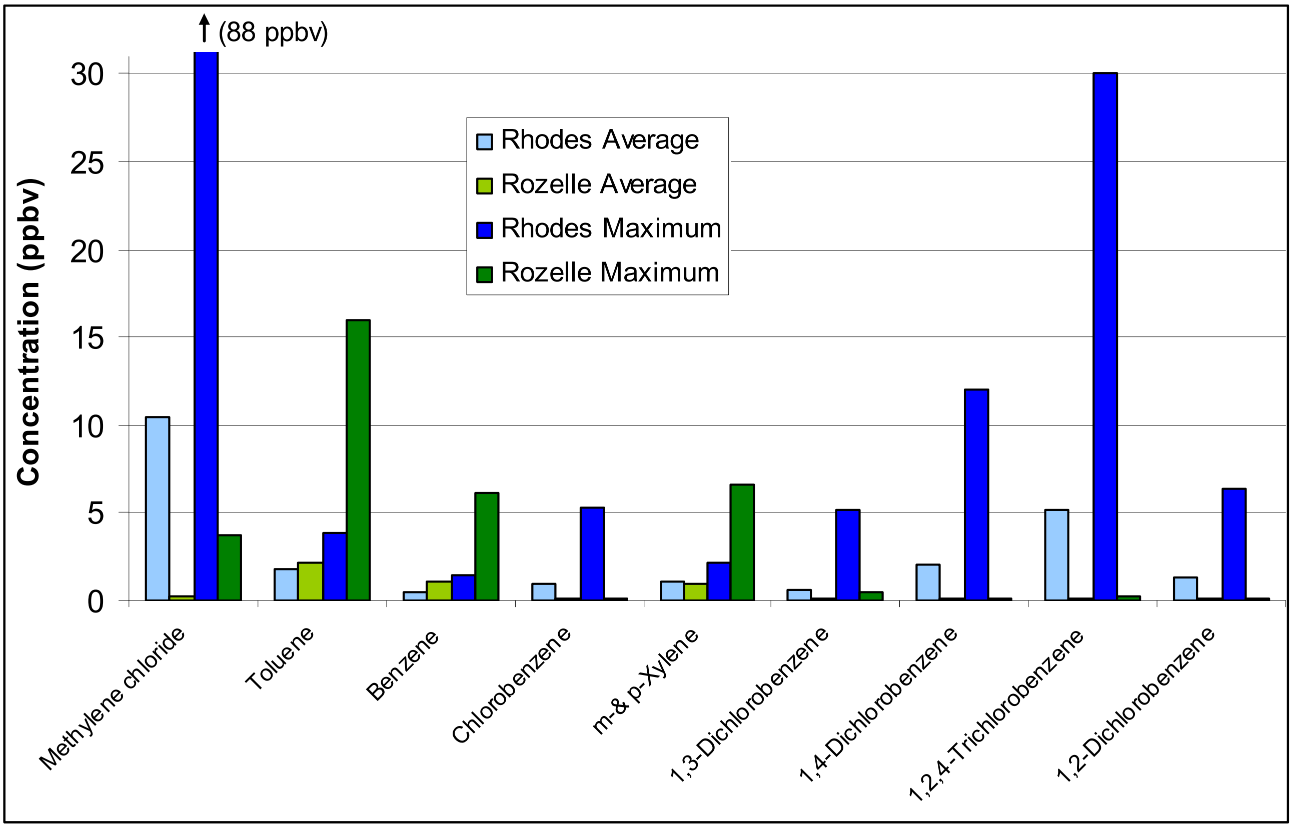


Figure 1-3 Comparison of Rhodes and Rozelle VOC Monitoring

1.3 Modelling Validation

A CALPUFF dispersion modelling exercise has been performed in order to establish whether concentrations measured at the VOC monitoring locations would be significantly different at Lot 100. On the basis of proximity, the application of Lednez boundary monitoring data to Lot 100 is considered conservative. In order to ensure this was so, dispersion modelling was performed for a 15 month period (September 2007 to November 2008) within which the sampling was undertaken. This allows the effect of meteorological influences to be included, such that judgement of the suitability of the adaptation of the Lednez monitoring data to Lot 100 can be made.

This modelling was performed for area sources at various locations on the Lednez site. Four source areas were considered, as shown on Figure 1-4. These are:

- Excavations (North) – Excavations at the northern region of the Lednez Site;
- Excavations (South) – Excavations adjacent to the Western Face of the Statewide building;
- Storage Cell – Cell of contaminated material covered by shade cloth; and
- Storage Ponds.

The areas of Lednez that are adjacent to the northern boundary (closest to Lot 100) were not included, as it is understood that remediation of these sections of the site has been completed. The impacts of each source location have been modelled independently, such that the relative emission contribution for each source type does not need to be established.

Appendix D VOC Monitoring Analysis

For this exercise, a puff model is considered far superior to Gaussian models such as AUSPLUME, given the requirement to calculate near source concentrations, coupled with the likely dominance of calm, stable conditions, and the associated accumulation, advection and diffusion of emissions, between successive hours. The sources were modelled in CALPUFF using an extended version of the meteorological dataset discussed in **Appendix A** (which spans the 15 month monitoring period), and the CALPUFF modelling setup detailed in **Appendix C**, with the following differences.

- Sources were represented as area sources, with a unity emission rate (1g/s/m^2), an initial vertical spread of 2m, and dimensions as indicated in Figure 1-4. Where sources were placed close to receptors, they were broken into smaller sources in order to minimise potential over-prediction associated with near-source limitations (which would provide an unrealistic model result);
- The model was run using “Slug Mode” which is considered by the model writers to provide improved calculation of near-field impacts;
- The model was run for a 15 month period (contemporaneous with the monitoring period), between September 1, 2007 and November 30, 2008.
- The model considered receptors at each of the monitoring locations, plus at the Lot 100 boundary. At Lot 100, receptor elevations of 1m, 10m, 20m, 30m, were included in order to assess concentrations for the vertical extent of the buildings in which occupation is proposed.
- It was assumed that emissions were constant in time.

Figure 1-4 Location of Modelled Sources and Receptors

1.3.1 Results

Table 1-3 presents the results from dispersion modelling. These figures represent the average concentration at each receptor location over the 15 month modelling period. The results are unitless, and represent the relative predicted concentration at each receptor location compared to the ground level concentration at Lot 100. Numbers greater than 1 indicate a greater predicted impact relative to ground level concentrations at Lot 100.

As can be seen in **Table 1-3**, for the vast majority of cases, emissions from the various sources have greater impact at the Monitoring locations, than at Lot 100. This implies that the adoption of the Lednez boundary monitoring data at Lot 100 is conservative.

Table 1-3 15 Month Average Dispersion Model Results - Normalised Against Predicted Concentrations Lot 100 (Ground Level)

Receptor Location	Excavations (South)	Storage Ponds	Excavations (North)	Storage Cell	Average
E1	2.5	1.8	1.2	12.5	4.5
S1	6.4	6.2	1.1	7.7	5.4
S2	18.1	15.9	1.1	1.6	9.2
S3	29.2	6.5	0.9	1.4	9.5
Lot 100 (Ground)	1.0	1.0	1.0	1.0	1.0
Lot 100 (10m)	0.6	0.6	0.5	0.5	0.5
Lot 100 (20m)	0.3	0.2	0.1	0.2	0.2
Lot 100 (30m)	0.1	0.1	0.1	0.1	0.1

1.4 Conclusion

VOC monitoring at the Lednez site boundary has been assumed to represent ambient concentrations resulting from all emissions on the Lednez site, excluding stack sources, which were modelled separately (see **Appendix C** for details on stack modelling). Validation modelling was performed for a range of source areas on the site, and indicated that the adoption of Lednez boundary monitoring data at Lot 100 is conservative. Thus the use of the VOC data in the following manner is considered appropriate:

- A representation of annual average non-stack VOC concentrations at Lot 100 has been calculated by the averaging of all 24-hour summa canister monitoring.
- A representation of peak 1 hour average non-stack VOC concentrations at lot 100 has been calculated using the peak results for each of analyte in all of the 8-hour and 24-hour summa canister monitoring. Worst case peak to mean ratios of 8 and 24 were used to adapt the 8-hour and 24-hour (respectively) sampling results to represent 1-hour average concentrations at Lot 100.

1.5 References

DEC (2004),*Ambient Air Quality Research Project (1996-2001) – Internal working paper no. 2 – Ambient concentrations of toxic organic compounds,* 2004.

Appendix E Chronic Exposure Assesment

Table 1 Chronic Assessment Lot 100, 42 Walker Street Rhodes

Chemical	Maximum Concentration Lednez Stack μg/m^3 Annual Average	Maximum Concentration Ambient Air Samples Lednez Boundary [1] μg/m^3 Annual Average	Total Concentration (Stack + Ambient Air) μg/m^3	Adopted Ambient Guidelines μg/m^3 NEPM	WHO [2,3]	USEPA	NHMRC	NSW DECC
				-	-	-	-	
Antimony	0.0006		0.0006	-	-	0.21~	-	0.09"
Arsenic	0.0005		0.0005	-	0.0006	0.00057	-	
Beryllium	0.000004		0.000004	-	-	0.001	-	0.004"
Cadmium	0.00003		0.00003	-	0.005	0.0014	-	0.018"
Chromium	0.00008		**0.00008**	-	-	0.000029	-	9"
Cobalt	0.00002		0.00002	-	-	0.00027	-	
Copper	0.00005		0.00005	-	-	-	-	18"
Manganese	0.0008		0.0008	-	0.15	0.052	-	180"
Mercury	0.0002		0.0002	-	1	0.31	-	1.8"
Nickel	0.001		0.001	-	0.0025	0.0051~	-	
Lead	0.00005		0.00005	-	0.5	-	-	
Selenium	0.00001		0.00001	-	-	-	-	
Tin	0.0004		0.0004	-	-	-	-	
Vanadium	0.00002		0.00002	-	1*	0.00029~	-	
Thallium	0.00009		0.00009	-	-	-	-	
Acetone	0.01		0.01	-	-	32000	-	22000"
Chloroform	0.005	2.23	2.2	-	140#	0.11	-	900"
Chloromethane		0.9	0.9	-	-	1.4	-	1900"
Benzene	0.01	1.6	1.7	9.58	0.16	0.31	-	29"
Bromomethane		1.8	1.8	-	-	5.2	-	
Toluene	0.1	6.7	6.8	376	260^	5200	-	
Chlorobenzene	0.1	4.2	4.3	-	-	52	-	
Dichlorodifluoromethane		3.0	3.0	-	-	210	-	
Ethylbenzene	0.005	1.9	1.9	-	22000	0.97	-	8000"
m-&p-xylene	0.01	4.6	4.6	868	870	730	-	
o-xylene	0.006	2.2	2.2	868	870	730	-	
Isopropylbenzene	0.005		0.005	-	-	420	-	
1,3,5_Trimethylbenzene	0.005	2.0	2.0	-	-	6.3	-	
1,2,4_Trimethylbenzene	0.005	2.69	2.7	-	-	7.3	-	
1,3-Dichlorobenzene	0.005	3.3	3.3	-	1000S	-	-	
1,2,4 Trichlorobenzene		38.3	38.3	-	50	4.2	-	
1,4-Dichlorobenzene	0.005	12.1	12.1	-	1000	0.22	-	
1,2-Dichlorobenzene	0.005	8.1	8.1	-	-	210	-	5500"
Hexachlorobutadiene	0.005		0.005	-	-	0.11	-	
TSP	0.2		0.2	-	-	-	-	90
HCl	0.03		0.03	-	-	-	-	
Cl	0.03		0.03	-	-	-	-	
Dioxins(TEQ)	0.000000002		0.000000002	-	-	-	0.00000066	0.000002"
Total Fluoride	0.006		0.006	-	-	-	-	
Sulfuric Acid Mist	0.10		0.10	-	-	-	-	18"
Styrene		1.8	1.8	-	260^	1000	-	
Nox	3.1		3.1	-	40	-	-	62
CO	0.05		0.05	-	-	-	-	10000J
PAHs	0.000001		0.000001	-	0.000011	-	-	0.4"
PCBs(Vapour)	0.00000002		0.00000002	-	-	0.0043~	-	
Dichloromethane	0.000000004	36.3	36.3	-	450^	5.2	-	3190"
Dibromoethane	0.00000001		0.00000001	-	-	0.0041	-	
B(a)P	0.000000003		0.000000003	0.0003	0.000011	0.00087	-	0.4"
DDD(dustborne)	0.00000010		0.0000001	-	-	0.025s	-	
Dieldrin(dustborne)	0.000000001		0.000000001	-	-	0.00053	-	
PCBs(dustborne)	0.0000001		0.0000001	-	-	-	-	
2-Chlorophenol	0.0000008		0.0000008	-	-	-	-	
Tetrachlorobenzene	0.00004		0.00004	-	-	-	-	
1,2,3,4-Tetrachlorobenzene(dustborne)	0.00004		0.00004	-	-	-	-	
1,2,3,5-Tetrachlorobenzene(dustborne)	0.00004		0.00004	-	-	-	-	
Pentachlorobenzene	0.000002		0.000002	-	-	-	-	
Hexachlorobenzene(vapour)	0.0000004		0.0000004	-	-	0.0053	-	
Hexachlorobenzene(dustborne)	0.000002		0.000002	-	-	-	-	
Napthalene(vapour)	0.00008		0.00008	-	-	0.072	-	
Napthalene(dustborne)	0.0000001		0.0000001	-	-	-	-	

References

~USEPA values for Antimony based on Trioxide, Nickel based on Subsulfide, Vanadium based on Pentoxide, and PCBs based on high risk

" Based on 1 hour averaging time

J Based on 8 hour averaging time

^ 1 week averaging time

***** 24 hour averaging time

#-WHO CICAD 2004 No 58

s- Surrogate Chemical, no screening guideline sourced, hence surrogate chemical adopted

1,3 Dichlorobenzene= 1,4 Dichlorobenzene

DDD= DDT

1-Summa Cannister Data adopted from Lednez Southern Boundary as representative of volatile emission sources from ground sources on site. 24 hour average concentrations have been adopted (maximum concentration).

2,3 WHO Air Quality Guidelines for Europe, Second Edition, WHO Regional Publications, European Series No. 91 2000 and WHO Guidelines for Air Quality,

NEPM- National Environment Protection (Air Toxics) Measure, December 2004, National Environment Protection Council

USEPA-Region IX Residential Air Guidelines, Screening levels for Chemical Contaminants at Superfund Sites (available online, 12th September 2008 latest update)

NHMRC-Dioxins: Recommendation for a Tolerable Monthly Intake for Australians, Endorsed 24th October 2002

NSW DECC-Impact Assessment Critiera, Individual Air Pollutants, Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales cancer risk is based on $1x10^{-6}$ acceptable risk level

BOLD- Indicates an exceedance of an adopted guideline

Appendix F Acute Exposure Asessment

Appendix F Acute Exposure Asessment

F1.1 Acute Inhalation Assessment Criteria

A range of different criteria are available for the assessment of potential human health effects associated with short-term emissions to air. No single organisation or methodology has developed acute criteria values or benchmarks for all potential compounds of concern. Hence, a hierarchical approach has been utilised for selecting existing guidelines for acute inhalation exposure levels.

Acute inhalation exposure criteria have been developed by a number of organisations which include: American Conference of Governmental Industrial Hygienists (ACGIH); Occupational Safety and Health Administration (OSHA); National Institute of Occupational Safety and Health (NIOSH); American Industrial Hygiene Association (AIHA), National Research Council on Toxicology (NRCT) USEPA; ATSDR, California Environmental Protection Agency (CalEPA); National Advisory Committee (NAC) and the US Department of Energy (DOE); Subcommittee on Consequence Assessment and Protective Actions (SCAPA); and National Occupational Health and Safety Commission (NOHSC).

The acute inhalation exposure criteria have been established by the above organisations and agencies to:

- Be protective of a range of exposure groups including occupational workers, military personnel and the general public;
- Based on a range of exposure durations, typically relevant to the exposure group, but ranging from 15 minutes, to 8 hours (typically for occupational settings) to 24 hours; and
- Protective of a range of toxicological endpoints such as mild discomfort, irritation, serious debilitating and potentially life-threatening effects up to and including death.

The hierarchical approach utilised in this assessment is based on that recommended by the USEPA Office of Solid Waste and detailed in the document “Human Health Risk Assessment protocol for Hazardous Waste Combustion Facilities” (Draft, USEPA 1998). The hierarchical approach is focused on the protection of the general public and is summarised below in order of preference:

1) Acute Exposure Guideline Levels (AEGLs) developed by the NAC/AEGL Committee and available from the USEPA;

2) Emergency Response Planning Guidelines (ERPGs) developed by the AIHA and SCAPA;

    4. Acute Reference Exposure Levels (ARELs) developed by the CalEPA;

    5. Temporary Emergency exposure limits (TEELs) developed by SCAPA; and

    6. SCAPA toxicity-based approach as presented by the DOE.

F1.2 Acute Exposure Guideline Levels (AEGLs)

Acute Exposure Guideline Levels (AEGLs) are under development by the US National Research Council's Committee on Toxicology. The committee developed detailed guidelines for developing uniform, meaningful emergency response standards for the general public. The criteria in the guidelines take into account sensitive individuals and are meant to protect nearly all people. The committee has started to put the guidelines into practice in developing AEGLs for specific chemicals. The guidelines define three-tiered AEGLs as follows:

- AEGL 1: The airborne concentration of a substance above which it is predicted that the general population, including susceptible individuals, could experience notable discomfort, irritation, or certain asymptomatic non-sensory effects. However, the effects are not disabling and are transient and reversible upon cessation of exposure.

Appendix F Acute Exposure Asessment

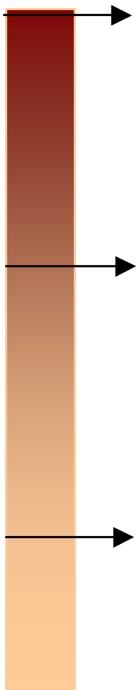
- AEGL 2: The airborne concentration of a substance above which it is predicted that the general population, including susceptible individuals, could experience irreversible or other serious, long-lasting adverse health effects or an impaired ability to escape.
- AEGL 3: The airborne concentration of a substance above which it is predicted that the general population, including susceptible individuals, could experience life-threatening health effects or death.

Each of the three levels of AEGL: AEGL-1, AEGL-2, and AEGL-3, have generally been developed for each of five exposure periods: 10 minutes, 30 minutes, 1 hour, 4 hours, and 8 hours.

F1.3 Emergency Response Planning Guidelines (ERPGs)

The Emergency Response Planning Guidelines (ERPGs) were developed by the ERPG committee of the American Industrial Hygiene Association. The ERPGs were developed as planning guidelines, to anticipate adverse human health effects caused by potential exposure to toxic chemicals. The ERPGs are a three-tiered guideline with one common denominator: a 1-hour contact (or average) duration. Each guideline identifies the substance, its chemical and structural properties, animal toxicology data, human experience, existing exposure guidelines, the rationale behind the selected value, and a list of references.

The three-tiered ERPG Exposure Guidelines. (Definitions and figure are from the ERPG publication).



ERPG-3
"is the maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to 1 hour without experiencing or developing life-threatening health effects."

ERPG-2
"is the maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to 1 hour without experiencing or developing irreversible or other serious health effects or symptoms which could impair an individual's ability to take protective action."

ERPG-1
"is the maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to 1 hour without experiencing other than mild transient adverse health effects or perceiving a clearly defined, objectionable odour."

The three-tiered ERPG Exposure Guidelines. (Definitions and figure are from the ERPG publication).

The ERPG guidelines are not designed to be protective of all individuals. Hypersensitive individuals may suffer adverse reactions to concentrations far below those suggested in the guidelines. ERPGs do not contain safety factors usually incorporated into exposure guidelines such as the AEGL. Rather, they estimate how the general public would react to chemical exposure.

Appendix F Acute Exposure Asessment

F1.4 Acute Reference Exposure Levels (ARELs)

Acute Reference Exposure Levels (AREL) have been established by the California EPA (Air Resources Board) for the protection of all individuals from any health impacts associated with short-term emissions to air. The AREL is an exposure level that is not likely to cause adverse health effects in human populations, including sensitive individuals, exposed to those concentrations for 1 hour on an intermittent basis. They are not specifically designed for accidental release situations but are designed for assessing the acute impacts of normal operations (with typical fluctuations). The derivation of the levels includes the use of safety factors and is considered to protective of mild adverse effects, similar to the ERPG-1 or TEEL-1 level.

F1.5 Temporary Emergency Exposure Limits (TEELs)

TEELs have been established (published by US DOE, January 2002) for a range of chemicals that are relevant for a range of potential health effects (defined as TEEL-0 to TEEL-3). They have been derived using an approved methodology utilised by the American Industrial Hygiene Association in developing a range of Emergency Response Planning Guidelines for a similar range of health effects (ERPGs, ranging from ERPG-1 to ERPG-3). ERPGs are only available for a small number of chemicals. The TEELs cover a much wider range of chemicals. TEELs are only considered “temporary” levels until ERPGs have been established for the chemical. Like ERPGs, they do not incorporate safety factors. Rather, they are designed to represent the predicted response of members of the general public to different concentrations of a chemical during an incident. TEELs are a four-tiered guideline based as follows:

- TEEL-0 The threshold concentration below which most people will experience no appreciable risk of health effects;
- TEEL-1 The maximum concentration in air below which it is believed nearly all individuals could be exposed without experiencing other than mild transient adverse health effects or perceiving a clearly defined objectionable odour. This level is similar to the ERPG-1;
- TEEL-2 The maximum concentration in air below which it is believed nearly all individuals could be exposed without experiencing or developing irreversible or other serious health effects or symptoms that could impair their abilities to take protective action. This level is similar to the ERPG-2; and
- TEEL-3 The maximum concentration in air below which it is believed nearly all individuals could be exposed without experiencing or developing life-threatening health effects. This level is similar to the ERPG-3.

TEELs are recommended to be relevant to the assessment of peak 15-minute time-weighted average concentrations.

Appendix G Toxicity Profile Chromium

G. Toxicity Profile Chromium

Chromium

General

Chromium is a naturally occurring element found in rocks, animals, plants, soil, and in volcanic dust and gases. Chromium is present in the environment in several different forms. The most common forms are chromium(0), trivalent (or chromium(III)), and hexavalent (or chromium(VI)). Chromium(III) occurs naturally in the environment and is an essential nutrient required by the human body to promote the action of insulin in body tissues so that sugar, protein, and fat can be used by the body. Chromium(VI) and chromium(0) are generally produced by industrial processes. No known taste or odour is associated with chromium compounds.

Chromium compounds show a wide range of solubilities with chromium(III) salts essentially insoluble (with the exception of chromium(III) chloride and nitrate that are soluble) and chromium(VI) soluble (with the exception of zinc and lead chromates). Hexavalent compounds are reduced to the trivalent form in the presence of oxidisable organic matter. This anaerobic decomposition may increase the mobility of chromium by forming more soluble complexes. The mobility on soil depends on the sorption characteristics of the soil with most chromium in soil strongly adsorbed onto soil particles (UK EA, 2002).

The fraction of chromium present in the hexavalent form is greater in industrial environments compared with ambient environments (UK, EA, 2002). Hexavalent and trivalent states are in dynamic equilibrium, with the degree of oxidation depending on various factors; for example in soil - moisture content, pH and the presence of reducing and oxidising agents. However, in most circumstances, chromium(VI) tends to be converted to chromium(III) when in contact with the natural environment, and for all practical purposes the oxidation of chromium(III) to chromium(VI) never occurs in biological systems. Chromium in foodstuffs is generally considered to be in the trivalent form.

Exposure and Health Effects

The following has been summarised from UK EA (2002) and WHO (2006):

Exposure to chromium may occur through the ingestion of food products containing chromium, inhalation of chromium particulates in air, ingestion of contaminated water or soil. Dermal absorption of chromium, particularly from soil, is not a significant route of exposure. In general, food appears to be the major source of intake. The toxicity of chromium depends on its oxidation state with chromium(VI) more toxic than chromium(III). Chromium(VI) compounds penetrate biological membranes much more readily than do chromium(III) compounds. After crossing cellular membranes, chromium(VI) may be reduced to chromium(III) via a number of reactions with a number of intermediates (pentavalent and tetravalent species) that may interact with essential constituents of the cells (including genetic material), which they can damage through oxidation and complexation with the resulting chromium species. As well as the inherently greater toxicity of hexavalent compared with trivalent chromium, the former is the more readily absorbed by both the inhalation and oral routes.

Chromium(III) is an essential nutrient that helps the body use sugar, protein, and fat. Deficiency of chromium(III) in the diet can result in weight loss or decreased growth, improper function of the nervous system, and a diabetic-like condition.

In general, Inhalation of high concentrations of chromium(VI) can cause irritation to the nose, such as runny nose, sneezing, itching, nosebleeds, ulcers, and holes in the nasal septum. Breathing in chromium(III) does not cause irritation to the nose or mouth in most people.

Long-term exposure to chromium, particularly chromium(VI) has been associated with lung cancer in workers exposed to levels in air that were 100 to 1,000 times higher than those found in the natural environment. Breathing in small amounts of chromium(VI) for short or long periods does not cause a problem in most people.

Chromium

In the same way, ingestion of small amounts of chromium(VI) is not considered to be toxic; however, accidental or intentional swallowing of larger amounts has the potential to cause stomach upsets and ulcers, convulsions, kidney and liver damage.

Besides its capacity to induce primary skin irritation and corrosion, direct contact with small amounts of chromium may be the cause of an allergic contact dermatitis. It is clear from occupational exposures that hexavalent chromium compounds are responsible for the majority of the cases of allergy to chromium. This is most likely explained by the fact that chromium(VI) penetrates the skin tissue better and is therefore more able than trivalent chromium to induce an allergic reaction. The role of the oxidation state of chromium in allergy is, however, complex.

Toxicity Classification

Chromium(VI) is classified as a "known" human carcinogen (Category A) by the USEPA for the inhalation route of exposure. Carcinogenicity by the oral route of exposure cannot be determined and is classified as Group D. Chromium(III) is not classified as to carcinogenicity and is in Group D.

The International Agency for Research on Cancer (IARC) has determined that chromium(VI) in air is carcinogenic to humans, while chromium(0), chromium(III) compounds and oral exposures to chromium(VI) are not classifiable as to their carcinogenicity to humans.

Hexavalent compounds have been shown to have mutagenic potential with positive results in a number of in vitro and in vivo studies. There is no consistent evidence that trivalent compounds have genetic activity.

Exposure Limits and Toxicity Evaluations

The NHMRC has presented a guideline value of 0.05 mg/L for chromium in the Australian Drinking Water Guidelines (2004) on the basis of the guideline value derived by the WHO and the point noted that the guideline value of 0.05 mg/L has been adopted by many countries with no known cases of chromium toxicity.

Review of the WHO provisional guideline of 0.05 mg/L indicates that the value is not derived on the basis of a specific threshold or non-threshold toxicity approach. Review by WHO in 2004 indicated that the guideline, while considered provisional, remained protective of human health as available toxicity data did not support revision of the guideline.

The US EPA derived a reference dose (RfD) of 0.003 mg/kg-day based on a NOAEL of 2.5 mg/kg-day from a drinking water study in rats. An uncertainty factor of 300 was used to account for interspecies and interhuman variability and the less-than-lifetime exposure in the principal study; a modifying factor of 3 was used to account for uncertainties related to reports of gastrointestinal effects following drinking water exposures in a residential population in China. This RfD is limited to soluble salts of hexavalent chromium (VI). The same study (from 1958) was used by the RIVM (2001) to establish a TDI of 0.005 mg/kg/day.

EPA derived a reference dose (RfD) of 1.5 mg/kg-day for chromium III. The critical study was conducted using chromic oxide. The NOAEL from this study (1,800 g/kg) was converted to a NOAEL for chromium (III) of 1,468 mg/kg-day by adjusting by a factor of 0.6849 g Cr/g Cr2O3 and then adjusting for continuous exposure. An uncertainty factor of 100 was used to account for interspecies and interhuman variability; a modifying factor of 10 was used to reflect database deficiencies (total = 1000). This RfD is limited to metallic chromium (III) of insoluble salts. Examples of insoluble salts include chromic III oxide (Cr2O3) and chromium (III) sulfate (Cr2 [SO4] 3). The USEPA has also established an inhalation unit risk of 0.012 $(\mu g/m^3)^{-1}$ for chromium(VI).

Chromium

RIVM (2001) has established and oral TDI for chromium(III) for both soluble compounds (0.005 mg/kg/day) and metallic and insoluble compounds (5 mg/kg/day). In addition a tolerable concentration in air of 0.06 mg/m^3 has been established for metallic and insoluble chromium(III) in air. For chromium(VI) a TDI of 0.005 mg/kg/day has been established as a provisional oral value with an inhalation risk concentration of 0.0025 µg/m^3 based on a 1 in 10,000 excess lifetime cancer risk. This value was established on the same basis as the WHO.

The WHO (2000) provides an inhalation unit risk of 0.04 (µg/m^3)$^{-1}$ for the assessment of inhalation exposures to chromium, based on lung cancer effects (i.e. for an air concentration of 1 µg/m^3, the lifetime risk is estimated to be 4.0x10^{-2}). This unit risk is the geometric mean of estimated lifetime risks calculated from various epidemiological data sets, which ranged from 0.13 to 0.011. The incremental risks calculated from these data sets have estimated lifetime risks from a lifetime exposure to chromium (VI) at a concentration of 1µg/m3. This is equivalent to the following slope factor (based on a 70kg body weight):

$$SF\ (mg/kg/day)^{-1} = Risk/Intake(mg/kg/day)$$
$$= [Risk \times Body\ Weight]/[Concentration\ (in\ air) \times Inhalation\ Rate)]$$
$$= [0.04 \times 70kg]/[0.001mg/m^3 \times 20\ m^3/day]$$
$$= 140\ (mg/kg/day)^{-1}$$

Suggested Toxicity Values for Risk Characterisation

Background Intake

For common contaminants, intakes from background sources such as food, water and/or air must also be considered in the evaluation and use of the ADI, TDI or RfD in assessing potential exposures to site related chemicals. For chromium a background intake of 13 µg/day has been estimated by the UK (2002) based on data for levels of chromium in food (most significant), water and air. It is also conservatively assumed that 10% of chromium in food and water is present in the hexavalent state. The RIVM (2001) has estimated background intakes of trivalent chromium to be 1 µg/kg/day and hexavalent chromium background intakes that vary from 0.01 to 30% of total chromium in air.

Toxicity Values

Toxicity data relevant for use in the characterisation of risk to human health have been selected for chromium following review of the available information in general accordance with guidelines from enHealth (2004) and NEPC (1999), accounting for background intake where relevant.

Oral	TDI = 0.003 mg/kg/day (USEPA current) for chromium(VI) TDI = 1.5 mg/kg/day (USEPA current) for chromium(III)
Dermal	No dermal guidelines are available, hence it has been assumed that dermal toxicity is equivalent to oral toxicity. However it is noted that the assessment does not adequately address dermal sensitivity (allergic contact dermatitis [ACD]). RIVM recommends a 10% threshold value be used to address ACD.
Inhalation	Inhalation Unit Risk = 0.04 (µg/m^3)$^{-1}$ (WHO, 2000), with an equivalent inhalation slope factor of 140 (mg/kg/day)$^{-1}$. Occupational inhalation exposure (ASCC/NOHSC): TWA: 0.5 mg/m^3 for chromium III and 0.05 mg/m^3 for chromium VI STEL: NA

Chromium

Background	Conservatively assumed to be 30% (based on background levels from the UK and a child body weight)

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Revision Dates

Document	**Revision**	**Date of Review**
Current Toxicity Summary	2007A	6/10/2007
Previous Revisions:	2005A	16/6/2005

Appendix H Risk Exposure Calculation

H. Risk Exposure Calculation

Toxicity and Dermal Absorption Parameters

Chemical	Non-Threshold Slope Factor				Threshold ADI, TDI or Reference Dose				Dermal	Occupational Exposure		Background Intake
	Oral	Inhalation		Dermal	Oral	Inhalation		Dermal	Permeability	TWA	TWA	
	$(mg/kg/day)^{-1}$	$(mg/kg/day)^{-1}$		$(mg/kg/day)^{-1}$	(mg/kg/day)	(mg/kg/day)		(mg/kg/day)	(cm/hr)	(mg/m^3)	(mg/kg/day)	(%)
Chromium		1.40E+02	WHO			1.50E+00	USEPA					30%

Inhalation of Particulates

Adult Resident

General Data/ Equations	Units	Exposure Parameters (RME) Inhalation Indoors by Adult Resident		Exposure Parameters (RME) Inhalation Outdoors by Adult Resident	
Exposure Parameters					
Exposure Frequency (EF)	days/year	337	Exposure for 52 weeks per year minus holidays	337	Exposure for 52 weeks per year minus holidays
Exposure Duration (ED)	years	55	Total lifetime exposure of 70 yrs assumed as per NEPM 1999 and CSMS 1996	55	Total lifetime exposure of 70 yrs assumed as per NEPM 1999 and CSMS 1996
Body Weight (BW)	kg	70	USEPA 1989 and CSMS 1996	70	USEPA 1989 and CSMS 1996
Averaging Time - NonThreshold (ATc)	days	25550	USEPA 1989 and CSMS 1996	25550	USEPA 1989 and CSMS 1996
Averaging Time - Threshold (ATn)	days	20075	USEPA 1989 and CSMS 1996	20075	USEPA 1989 and CSMS 1996
Inhalation Rate (InhR)	m^3/hr	1.10	Inhalation rate indoors for adults as per enHealth 2002	2.20	Inhalation rate for adults outdoors similar to walking as per CSMS 1996
Exposure Time (ET)	hr/day	20	Assume resident spends 20 hours Indoors	4	Assume resident spends 4 hours outdoors
Deposition Fraction (DF)	-	0.75	75% of inhaled dust will be retained in respiratory tract with remaining 25% exhaled (NEPM 1999)	0.75	75% of inhaled dust will be retained in respiratory tract with remaining 25% exhaled (NEPM 1999)
Cilliary Clearance Factor (CC)	-	0.5	50% of inspirable dust small enough to reach pulmonary alveoli - this is the respirable fraction (if particulate data used is respirable fractions, 100% assumed)	0.5	50% of inspirable dust small enough to reach pulmonary alveoli - this is the respirable fraction (if particulate data used is respirable fractions, 100% assumed)
Fraction Inhaled from Contaminated Source (FI)	-	1	Assume all of workplace above groundwater/soils	1	Assume all of workplace above groundwater/soils
Intake Factor = InhR*ET*DF*CC*FI*EF*ED / BW*AT	m^3/kg/day	**8.5E-02**	**NonThreshold**	**3.4E-02**	**NonThreshold**
		1.1E-01	**Threshold**	**4.4E-02**	**Threshold**

Daily Intake from Air = Concentration in Air x Intake Factor
NonThreshold Risk = Daily Intake from Air for NonThreshold Effects x Slope Factor
Hazard Quotients = (Daily Intake from Air for Threshold Effects/ADI)

Chemical	Toxicity Data: Non-Threshold Slope Factor	Toxicity Data: Threshold ADI, TDI or RfD	Concentration in Indoor Air	Daily Intake: Daily Intake from Air - NonThreshold	Daily Intake: Daily Intake from Air - Threshold	Calculated Risk: NonThreshold Risk	Calculated Risk: Hazard Quotient	Concentration in Outdoor Air	Daily Intake: Daily Intake from Air - NonThreshold	Daily Intake: Daily Intake from Air - Threshold	Calculated Risk: NonThreshold Risk	Calculated Risk: Hazard Quotient
	$(mg/kg\text{-}day)^{-1}$	(mg/kg/day)	(mg/m^3)	(mg/kg/day)	(mg/kg/day)	(unitless)	(unitless)	(mg/m^3)	(mg/kg/day)	(mg/kg/day)	(unitless)	(unitless)
					TOTAL	**9.6E-7**	**8.3E-9**			**TOTAL**	**3.8E-7**	**3.3E-9**
Chromium	1.4E+02	1.1E+00	8.00E-08	6.8E-09	8.7E-09	9.6E-7	8.3E-9	8.00E-08	2.7E-09	3.5E-09	3.8E-7	3.3E-9

↑ Maximum Concentration from Stack Emissions (indoor air)

↑ Maximum Concentration from Stack Emissions (outdoor air)

Inhalation of Particulates

Older Children

General Data/ Equations	Units	Exposure Parameters (RME) Inhalation Older Dhild Indoors		Exposure Parameters (RME) Inhalation Older child Outdoors	
Exposure Parameters					
Exposure Frequency (EF)	days/year	337	Exposure for 52 weeks per year minus holidays	337	Exposure for 52 weeks per year minus holidays
Exposure Duration (ED)	years	10	Total exposure during ages 5 to 10 years	10	Total exposure during ages 5 to 10 years
Body Weight (BW)	kg	34.5	USEPA 1989 and CSMS 1996	34.5	USEPA 1989 and CSMS 1996
Averaging Time - NonThreshold (ATc)	days	25550	USEPA 1989 and CSMS 1996	25550	USEPA 1989 and CSMS 1996
Averaging Time - Threshold (ATn)	days	3650	USEPA 1989 and CSMS 1996	3650	USEPA 1989 and CSMS 1996
Inhalation Rate (InhR)	m^3/hr	0.60	Inhalation rate indoors for adults as per enHealth 2002	1.60	Inhalation rate equivalent to walking/running at 3.5 km/hr, enHealth 2003 and
Exposure Time (ET)	hr/day	20	Assume older child resident spends 20 hours indoors	4	Assume older child resident spends 4 hours outdoors
Deposition Fraction (DF)	-	0.75	75% of inhaled dust will be retained in respiratory tract with remaining 25% exhaled (NEPM 1999)	0.75	75% of inhaled dust will be retained in respiratory tract with remaining 25% exhaled (NEPM 1999)
Cilliary Clearance Factor (CC)	-	0.5	50% of inspirable dust small enough to reach pulmonary alveoli - this is the respirable fraction (if particulate data used is respirable fractions, 100% assumed)	0.5	50% of inspirable dust small enough to reach pulmonary alveoli - this is the respirable fraction (if particulate data used is respirable fractions, 100% assumed)
Fraction Inhaled from Contaminated Source (FI)	-	1	Assume all of workplace above groundwater/soils	1	Assume all of workplace above groundwater/soils
Intake Factor = InhR*ET*DF*CC*FI*EF*ED / BW*AT	m^3/kg/day	**1.7E-02**	**NonThreshold**	**9.2E-03**	**NonThreshold**
		1.2E-01	**Threshold**	**6.4E-02**	**Threshold**

Daily Intake from Air = Concentration in Air x Intake Factor
NonThreshold Risk = Daily Intake from Air for NonThreshold Effects x Slope Factor
Hazard Quotients = (Daily Intake from Air for Threshold Effects/ADI)

Chemical	Toxicity Data: Non-Threshold Slope Factor	Toxicity Data: Threshold ADI, TDI or RfD	Concentration in Indoor Air	Daily Intake: Daily Intake from Air - NonThreshold	Daily Intake: Daily Intake from Air - Threshold	Calculated Risk: NonThreshold Risk	Calculated Risk: Hazard Quotient	Concentration in Outdoor Air	Daily Intake: Daily Intake from Air - NonThreshold	Daily Intake: Daily Intake from Air - Threshold	Calculated Risk: NonThreshold Risk	Calculated Risk: Hazard Quotient
	$(mg/kg\text{-}day)^{-1}$	(mg/kg/day)	(mg/m^3)	(mg/kg/day)	(mg/kg/day)	(unitless)	(unitless)	(mg/m^3)	(mg/kg/day)	(mg/kg/day)	(unitless)	(unitless)
					TOTAL	**9.4E-7**	**4.5E-8**			**TOTAL**	**1.0E-7**	**4.9E-9**
Chromium	1.4E+02	1.1E+00	3.92E-07	6.7E-09	4.7E-08	9.4E-7	4.5E-8	8.00E-08	7.3E-10	5.1E-09	1.0E-7	4.9E-9

↑ Maximum Concentration from Stack Emissions (indoor air)

↑ Maximum Concentration from Stack Emissions (outdoor air)

Inhalation of Particulates

Younger Children

General Data/ Equations	Units	Exposure Parameters (RME) Inhalation Young Children Indoors		Exposure Parameters (RME) Inhalation Young Children Outdoors	
Exposure Parameters					
Exposure Frequency (EF)	days/year	337	Exposure for 52 weeks per year minus holidays	337	Exposure for 52 weeks per year minus holidays
Exposure Duration (ED)	years	5	Lifetime exposure for age group	5	Lifetime exposure for age group
Body Weight (BW)	kg	13.2	NEPM 1999 and CSMS 1996	13.2	NEPM 1999 and CSMS 1996
Averaging Time - NonThreshold (ATc)	days	25550	USEPA 1989 and CSMS 1996	25550	USEPA 1989 and CSMS 1996
Averaging Time - Threshold (ATn)	days	1825	USEPA 1989 and CSMS 1996	1825	USEPA 1989 and CSMS 1996
Inhalation Rate (InhR)	m^3/hr	0.40	Inhalation rate indoors for younger children as per CSMS 1991	1.25	Inhalation rate for young children outdoors as per CSMS 1996
Exposure Time (ET)	hr/day	20	Assumeyounger child resident is home for 20 hours per day	4	Assume young child spends 4 hours outdoors
Deposition Fraction (DF)	-	0.75	75% of inhaled dust will be retained in respiratory tract with remaining 25% exhaled (NEPM 1999)	0.75	75% of inhaled dust will be retained in respiratory tract with remaining 25% exhaled (NEPM 1999)
Cilliary Clearance Factor (CC)	-	0.5	50% of inspirable dust small enough to reach pulmonary alveoli - this is the respirable fraction (if particulate data used is respirable fractions, 100% assumed)	0.5	50% of inspirable dust small enough to reach pulmonary alveoli - this is the respirable fraction (if particulate data used is respirable fractions, 100% assumed)
Fraction Inhaled from Contaminated Source (FI)	-	1	Assume all of workplace above groundwater/soils	1	Assume all of workplace above groundwater/soils
Intake Factor = InhR*ET*DF*CC*FI*EF*ED / BW*AT	m^3/kg/day	**1.5E-02**	**NonThreshold**	**9.4E-03**	**NonThreshold**
		2.1E-01	**Threshold**	**1.3E-01**	**Threshold**

Daily Intake from Air = Concentration in Air x Intake Factor
NonThreshold Risk = Daily Intake from Air for NonThreshold Effects x Slope Factor
Hazard Quotients = (Daily Intake from Air for Threshold Effects/ADI)

Chemical	Toxicity Data: Non-Threshold Slope Factor	Toxicity Data: Threshold ADI, TDI or RfD	Concentration in Indoor Air	Daily Intake: Daily Intake from Air - NonThreshold	Daily Intake: Daily Intake from Air - Threshold	Calculated Risk: NonThreshold Risk	Calculated Risk: Hazard Quotient	Concentration in Outdoor Air	Daily Intake: Daily Intake from Air - NonThreshold	Daily Intake: Daily Intake from Air - Threshold	Calculated Risk: NonThreshold Risk	Calculated Risk: Hazard Quotient
	$(mg/kg\text{-}day)^{-1}$	(mg/kg/day)	(mg/m^3)	(mg/kg/day)	(mg/kg/day)	(unitless)	(unitless)	(mg/m^3)	(mg/kg/day)	(mg/kg/day)	(unitless)	(unitless)
					TOTAL	**1.7E-7**	**1.6E-8**			**TOTAL**	**1.0E-7**	**1.0E-8**
Chromium	1.4E+02	1.1E+00	8.00E-08	1.2E-09	1.7E-08	1.7E-7	1.6E-8	8.00E-08	7.5E-10	1.0E-08	1.0E-7	1.0E-8

↑ Maximum Concentration from Stack Emissions (indoor air)

↑ Maximum Concentration from Stack Emissions (outdoor air)

Summary of Risks Lot 100, Meriton	Total Non-Threshold Risks	Total Threshold Risks
Lot 100 Residents		
Adults Inhalation Indoors	9.58E-07	0.000000008
Adults Inhalation Outdoors	3.83E-07	0.000000003
Older Children Inhalation Indoors	9.43E-07	0.00000004
Older Children Inhalation Outdoors	1.03E-07	0.000000005
Younger Children Inhalation Indoors	1.68E-07	0.00000002
Younger Children Inhalation Outdoors	1.05E-07	0.00000001
Sum of Lifetime Risks	**2.66E-06**	**0.00000004**
Target Risk	**$1x10^{-5}$**	**1.0**