Coal dust in our suburbs: A community-led study of particle pollution in Newcastle and the Lower Hunter coal train corridor

Prepared by the Coal Terminal Action Group Dust and Health Steering Group

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- The families in the twelve houses where we monitored.
- More than 100 community members who donated to make this study possible.
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- Mike Fry of Turnkey Instruments who provided excellent technical support and data management.

[1] Professor Bridgman and Dr Sweeney do not represent any group or organisation.

Executive Summary

During December 2012 and January 2013, community groups monitored air quality at twelve residences in Newcastle and the Lower Hunter to assess the level of particle pollution in residential areas close to coal trains and stockpiles.

This report presents an overview of the study, and presents the results from sites where substantial air pollution issues were indicated during this monitoring period. The analysis of monitoring data and the conclusions drawn are based upon independent analysis and interpretation carried out by air quality experts Associate Professor Howard Bridgman and Dr Jill Sweeney.

There is a lack of data about ambient air quality in localities within close proximity to industrial (specifically coal) infrastructure around the Port of Newcastle and along coal rail lines in Newcastle and the Hunter. Coal loaders, stockpiles, trains and rail corridors are substantial sources of coal-related particle pollution, which is of significant concern to many residents in Newcastle and the Hunter. For these reasons, the Coal Terminal Action Group, which comprises eighteen community and environment groups, initiated monitoring of PM_{10}, $PM_{2.5}$ and PM_1 at twelve representative sites in Newcastle and the Lower Hunter, from Carrington (the Newcastle suburb closest to coal loading) to Lochinvar (a rural location in the Lower Hunter).

Comprehensive international studies demonstrate direct causal links between particle pollution and adverse health impacts, particularly respiratory and cardio-vascular diseases such as asthma, hypertension, heart disease and lung damage. It is also well established that there are no known 'safe' levels of exposure to particle pollution, below which there are no health effects.

Air quality in the Upper and Lower Hunter exceeds health standards. The National Environment Protection Measure (NEPM) for Ambient Air defines the national standard for particle pollution. According to the NEPM, particle concentrations averaged over 24 hours should remain below 50 micrograms per cubic metre (μgm^{-3}). The NEPM allows for five exceedances of this standard in a calendar year, to account for natural events such as bushfires and dust storms. However, locations around Newcastle and the Hunter are already experiencing far more than five exceedances of this standard each year. This is demonstrated by EPA monitors throughout the Hunter and by the industry-funded ambient air quality monitor in Stockton, which recorded thirteen exceedances of the PM_{10} standard in less than four months.

Monitoring undertaken during this study revealed concentrations of particle pollution well above the NEPM standard. Particle concentrations in Tighes Hill and Carrington reached or exceeded the NEPM for PM_{10} on five of the seven days of monitoring. In Carrington, the NEPM standard was exceeded on every day of monitoring, and three 24-hour PM_{10} averages were above $75\mu gm^{-3}$ - 50% higher than the standard.

Monitoring demonstrated that the suburbs closest to the Port of Newcastle and industrial infrastructure such as coal loaders and coal train lines, experience worse air quality (PM_{10} and $PM_{2.5}$) compared with the Newcastle EPA monitor. Particle concentrations in Mayfield, Mayfield East, Tighes Hill and Carrington are generally two to four times higher than recorded by the EPA's monitor

during the same time period. The EPA monitor is approximately three kilometres away from the nearest source of coal at Carrington.

In summary, the study provides a rationale for decisive intervention to improve urban air quality in Newcastle and the Lower Hunter, specifically in those locations near coal infrastructure. Findings from this monitoring demonstrate the air quality standard has been reached and exceeded in several locations. This must be taken into account in the assessment of future development applications with potential air quality impacts.

Table of Contents

List of Figures

List of Tables

Glossary

ANSTO Australian Nuclear Science Technology Association
ARTC Australian Rail Track Corporation Ltd
CTAG Coal Terminal Action Group
EA Environmental Assessment
EPA Environment Protection Authority (NSW)
NEPC National Environment Protection Council
NEPM National Environment Protection Measure
OEH Office of Environment and Heritage (NSW)
PAC Planning Assessment Commission
PM Particulate matter
PM_1 Particulate matter of 1 or less micrometre in diameter
$PM_{2.5}$ Particulate matter of 2.5 or less micrometres in diameter
PM_{10} Particulate matter of 10 or less micrometres in diameter
PWCS Port Waratah Coal Services
T4 Proposed fourth coal terminal in Newcastle
µg microgram
µm micrometre

Introduction

The need for this Study

Concern is growing that Newcastle and other 'coal corridor' communities are exposed to elevated levels of particle pollution. This exposure causes a range of serious short-term and long-term health impacts (Colagiuri, Cochrane and Girgis, 2012). NSW Health has cautioned against the construction of a fourth coal terminal in Newcastle (PWCS' T4) due to the impacts of existing pollution levels and the modelled increases in coal dust during its construction and operation. The fourth terminal would increase the port's export capacity by 110 million tonnes per annum, resulting in an estimated 107 more train movements each day (based on train movement modelling in the T4 EA).

The particles associated with coal mining, coal transport and the diesel emissions from coal trains are monitored at locations throughout the Hunter Valley. During 2012, monitoring stations recorded 98 exceedances of the national standard for PM_{10}. Residents who subscribe to the EPA's air pollution alerts often receive more than one each day, especially on dry, windy days when dust is blown from the Valley's vast open cut mines.

Despite questions being raised about the health impacts of particle pollution and evidence of ongoing exceedances from existing sources, the NSW Government seems supportive of the T4 proposal. Planning Minister Brad Hazzard has referred the project to a Planning Assessment Commission to weigh up the merits and impacts of the project. Approximately 500 submissions were received by the Department of Planning during the exhibition period in early 2012, with 90% opposing the terminal. In their submission on T4, NSW Health noted that there are already exceedances of the national PM_{10} standard in Newcastle and that uncovered coal wagons and diesel emissions will increase particle pollution in residential areas between the mines and the port.

The coal industry and NSW EPA refute these health concerns, alleging that coal trains are not a significant source of particle pollution and that particle pollution diminishes rapidly with distance from the coal corridor. In response to community concern, the Australian Rail Track Corporation Ltd (ARTC) conducted particle monitoring at Mayfield and Metford within the Hunter coal corridor from December 2011 to January 2012. The ARTC report was submitted to the EPA in June 2012 and was not publicly released until late September, despite regular requests from the public and a 'call for papers' in the NSW Legislative Council. The Dust and Health Study Community Steering Group investigated the ARTC report in detail and published a detailed critique of this study in October. This highlighted its failures, particularly poor choice of locations and the comparison of dust levels associated with different train types without reporting 'background' air quality when no trains were passing the monitors. Despite assurance that the raw data from the ARTC study will be provided, at the time of writing CTAG is still waiting to receive this information to compare results.

Due to growing concerns about particle pollution around the Port of Newcastle and coal rail corridors, and the potential increased impact should T4 be approved, the Dust and Health Community Steering Group was formed in July 2012. In response to what the local community see as the failure of government and industry to adequately assess the health impacts of particle pollution, the Steering Group resolved to undertake independent, 'snapshot' air quality monitoring for PM_{10}, $PM_{2.5}$ and PM_1 within residential areas close to the Port and rail corridors. The study is intended as a preliminary investigation.

The Regulatory Framework

In 1998 the National Environment Protection Council (NEPC) finalised the National Environment Protection Measure (NEPM). Under the NEPM for Ambient Air Quality, Australian Governments established a national outdoor air quality standard for PM_{10} of 50µgm^{-3}, averaged over a 24-hour period. The goal, which was intended to be met by 2008, is for this level to be exceeded no more than five days per calendar year.

The NEPM was revised in 2003 to include advisory (non-binding) reporting standards for $PM_{2.5}$; an average of 25µgm^{-3} over 24 hours and 8µgm^{-3} averaged over one year. The inclusion of the $PM_{2.5}$ guideline levels was intended to gather sufficient $PM_{2.5}$ monitoring data in order to develop binding air quality standards for this particle size range. This has not occurred and the above levels for $PM_{2.5}$ remain as advisory guidelines.

The EPA and several coal mining companies conduct air quality monitoring in various locations throughout the Hunter Valley; however, this monitoring does not specifically measure community exposure close to the coal loading terminals and coal rail corridors. The EPA ambient air monitors are located in Cooks Hill[2] (No 1 Sportsground near Dumaresq Street), Wallsend (Wallsend swimming pool) and Beresfield (Francis Greenway High School). The Cooks Hill monitor is located approximately 3 km south from the nearest source of coal dust (the Carrington Coal Terminal). The monitors in Beresfield and Wallsend collect data on PM_{10} and $PM_{2.5}$ and the monitor in Cooks Hill only collects data on PM_{10}.

There are currently no national standards for PM_1, nor is there international agreement on methods for the measurement and reporting of this particle size range. However, these very fine particles are particularly harmful to health. The EPA monitors do not record PM_1 data; and industry is not required to publish any PM_1 data that they have collected (if any such data is in fact collected).

Last year, the national PM_{10} standard was exceeded 98 times in Newcastle and the Hunter and the EPA issued 36 air quality alerts during October. The relatively new air quality monitor in Fullerton Street Stockton, funded by Orica, recorded 13 PM_{10} exceedances between 13 Oct 2012 and 1 Feb 2013, including 24-hour average levels up to 80µgm^{-3}. Hourly PM_{10} averages in Stockton have been as high as 200µgm^{-3}. Despite clear evidence of an air pollution problem in and around Newcastle and the Lower Hunter, the NSW Environment Protection Authority and industry have played down local residents' concerns.

Health Impacts of Particle Pollution

The health and social harms of coal mining and transport in the Hunter are well documented (Colagiuri et al, 2012). International research demonstrates that people living in coal-affected communities are more likely to suffer heart, lung and kidney cancer, respiratory and cardiovascular disease and birth defects, among other effects. There is a direct link between long-term exposure to particle pollution and hospital admissions, emergency department attendance, asthma, respiratory and cardiovascular disease, congestive heart failure and premature death (Colagiuri et al, 2012).

PM_{10} and smaller particles are known to cause the above health impacts, even at commonly occurring levels of ambient air pollution as experienced in cities and industrial areas. Very fine to ultrafine particles (PM_1 and smaller) are particularly harmful to health due to their tiny size, which allows them to be transported over large distances in the air as well as throughout the body

[2] The EPA's Newcastle monitor is located at a junction of suburbs including: Newcastle, Cooks Hill, Newcastle West and Hamilton South. In this report the location is referred to as 'Cooks Hill'.

following inhalation. Furthermore, contaminants attached to these fine particles can be more readily transported to and absorbed by various tissues and organs.

Studies have clearly established that, as with asbestos and other toxics exposure, there is no safe level of airborne particulate matter. The NEPM standards and guidelines do not safeguard our health, but provide an arbitrary threshold for governments to aim for. More frequent exposures to PM_{10} and $PM_{2.5}$ just below the NEPM 24 hour average standard and guideline (respectively) have more deleterious health effects than less frequent exposures to levels just above the NEPM standard and guidelines.

Cumulative Impacts of Increasing Coal Exports

The Environmental Assessment for T4 predicts annual PM_{10} emissions from Stage 1 loader operation of 86.2 tonnes, and from the final Stage 3 of 150.2 tonnes. This prediction is based on calculations for the coal loader and inbound trains. It does not assess the additional dust and diesel emissions from outbound coal trains that would add to the total particle pollution. The T4 EA claims the project would add an average of $6\mu gm^{-3}$ PM_{10} per day into the air, and therefore not cause any additional exceedances of the daily NEPM based on the historical data recorded by the EPA. However, this modelling is based on 2010 as a single baseline year, which is not representative of air quality conditions in Newcastle over longer time periods. Furthermore, our study demonstrates that air quality is significantly poorer in the suburbs close to existing industry and the site of the proposed T4, compared to the EPA site at Cooks Hill. The claims in the EA that T4 would not contribute to additional exceedances are not able to be substantiated given the limited information used in the EA. This study demonstrates more work needs to be done, particularly in the suburbs closest to the proposed site, to be able to assess likely impacts.

Objectives of this Study

The objectives of the air quality monitoring study were to inform the community of:

- The level of particle pollution we are currently living with;
- The relationship between particle pollution levels and proximity to coal infrastructure (trains, stockpiles, etc.); and
- The extent to which elevated levels of particle pollution persist at various distances from the coal corridor and coal infrastructure.

This is intended as an initial scoping study, serving as a pilot for a larger study. It has been designed with technical advice from two of Australia's leading air quality experts, Professor Lidia Morawska (Queensland University of Technology) and Associate Professor Howard Bridgman (the University of Newcastle). Associate Professor Bridgman and Dr Jill Sweeney collated and analysed the data and provided interpretative notes which are incorporated in this report. The views expressed in this report are the views of the Coal Terminal Action Group and not necessarily the views of Associate Professor Bridgman or Dr Sweeney.

Methodology

Equipment

Three Osiris™ DustTrak portable air quality monitors were used. The monitors simultaneously recorded PM_1, $PM_{2.5}$ and PM_{10} at either one minute or 10 minute intervals; as well as wind direction and speed. Each monitor was calibrated before the study began and all three monitors were tested simultaneously at the start of the study. The monitors were used according to the manufacturer's specifications.

The monitors were deployed within residential properties at the following sites:

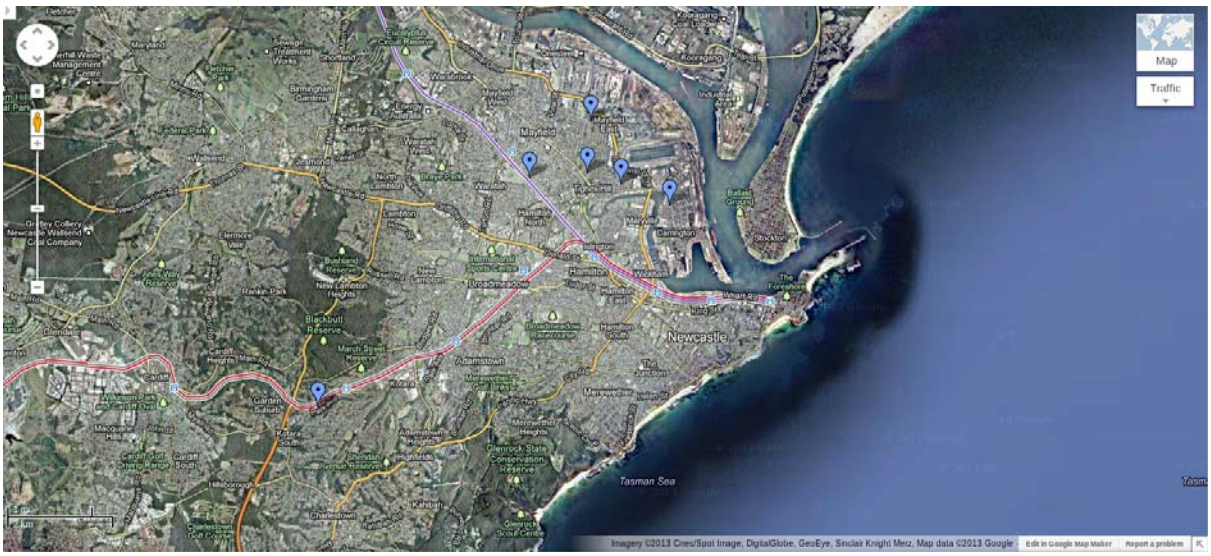
1. Crebert Street, Mayfield;
2. Upfold Street, Mayfield;
3. O'Mara Street, Mayfield East;
4. Garrett Street, Carrington;
5. Henry Street, Tighes Hill;
6. Park Avenue, Kotara;
7. Maitland Road, Hexham;
8. Deschamps Close, Thornton;
9. Charles Street, East Maitland;
10. Cumberland Road, East Maitland;
11. Winders Road, Lochinvar; and
12. Chinchen St, Islington.

Data for Chinchen St, Islington was recorded; however, was excluded from the analysis due to incomplete data sets.

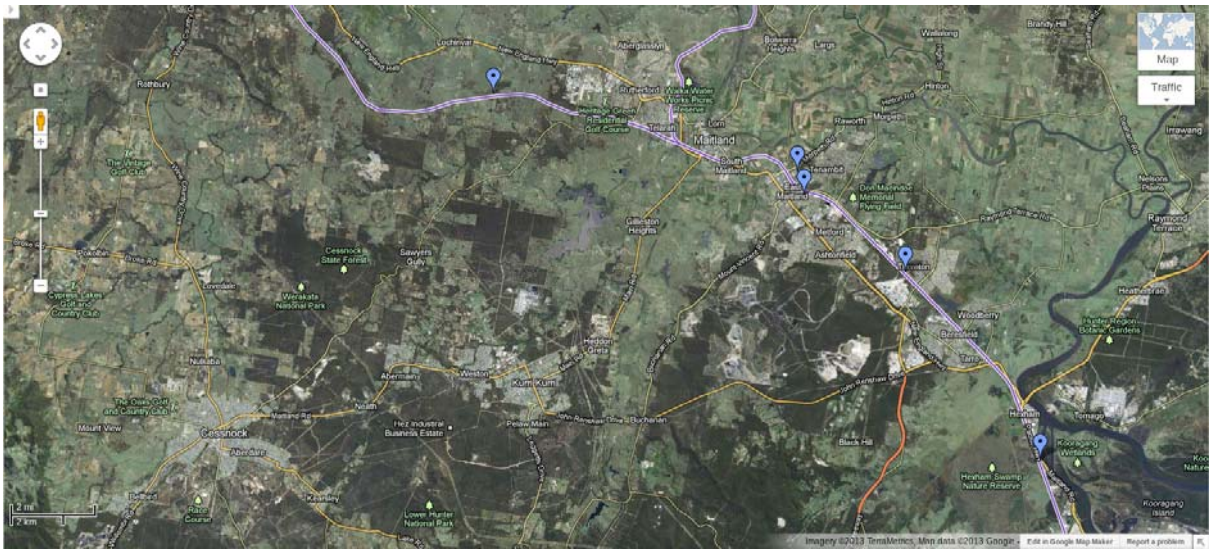
Differences in measurement of PM_{10} and $PM_{2.5}$ were noted between monitors when operated synchronously at the same location. Results are therefore, indicative.

Locations

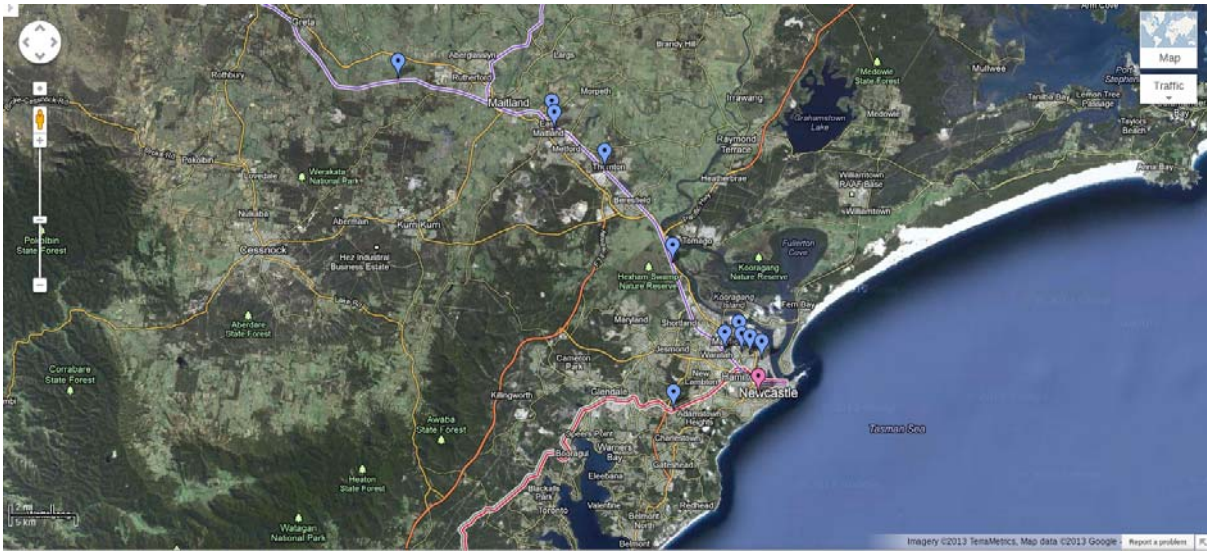
The approximate location of each monitoring site is shown on maps 1, 2 and 3. An overview map is also provided.



Map 1: Newcastle cluster of dust monitoring locations



Map 2: Lower Hunter cluster of dust monitoring locations



Map 3: All Orisis dust monitoring locations used in this study

Picture 1: Representative testing Osiris dust monitor

Care was taken to ensure that the monitors were positioned to minimise environmental interference such as trees, houses, driveways and so on. The monitors were typically positioned in open lawn areas in the back yards of residences.

Recording and Reporting Air Quality and Wind Conditions

The monitors recorded PM_1, $PM_{2.5}$ and PM_{10} simultaneously, at either one minute or 10 minute intervals. One-minute interval data were converted to ten-minute averages to ensure consistency of the data set. From these 10 minute averages the 24 hour average concentrations of PM_{10}, $PM_{2.5}$ and PM_1 were calculated. Particulate matter was recorded as mass in micrograms (µg) per cubic metre (m^3) of air, in accordance with international standards. There is currently no international standard for the collection, interpretation and reporting of PM_1, due to the complexity and variability of particles within this size range. However, PM_1 was recorded in μgm^{-3} at all locations. It has been reported as a percentage of the total mass of PM_{10} particles at selected locations described in this report.

The monitors also recorded wind speed and wind direction at ten minute intervals. Where less than 24 hours of data were recorded at a given site (including at the beginning and/or end of a recording interval that included whole days), all recorded data from these periods were removed from the data set prior to calculation of the 24 hour averages. In addition, some anomalously high outliers were recorded in some data sets; these were removed prior to calculation of the 24 hour averages.

The EPA air quality monitors at Beresfield (Francis Greenway High School, Lawson Avenue) and Wallsend (Wallsend Swimming Pool, Frances Street) record PM_{10} and $PM_{2.5}$; however, the EPA monitor at Newcastle (Dumaresq Street Cooks Hill) records PM_{10} only. The Orica air quality monitor at Stockton (Fullerton Street) monitors PM_{10} and $PM_{2.5}$. We compared 24 hour averages of PM_{10} from our monitoring locations with those from the closest EPA monitor (either Newcastle or Beresfield) and the Stockton monitor for city monitoring locations.

How to Interpret the Graphs

The NEPM standard for PM_{10} is an average of $50\mu gm^{-3}$ during each 24 hour period. This level is shown as a red line on the bar graphs depicting 24 hour particulate concentrations. The National reporting guideline for $PM_{2.5}$ is $25\mu gm^{-3}$ in a 24 hour period. This level is shown as a broken black line

on the bar graphs depicting 24 hour particulate concentrations. In some of the bar graphs we have also included a comparison with the nearest EPA air quality monitor (located in Cooks Hill or Beresfield), as well as the Orica Stockton air quality monitor for city locations. These graphs also distinguish the NEPM and reporting guidelines for PM_{10}.

The polar graphs depict each ten-minute $PM_{2.5}$ or PM_{10} reading as a single point. The distance from the centre of the circle corresponds to the concentration (in μgm^{-3}) according to the scale used. The direction of each point in relation to the centre depicts the wind direction at the time the reading was taken. The polar graphs depict the entire monitor readings recorded at each location, including the days that were removed from the 24 hour averages. Because dust was recorded during most 10 minute intervals across all sites, where the polar graphs show no points in a particular direction, it means that the wind was not blowing from this direction during the study period.

Results

The results from case study sites are provided below. Appendix A contains the 24 hour averages of every site, with a comparison to the EPA and Orica air quality monitors.

O'Mara Street, Mayfield East (Osiris monitor 2654)

This site was monitored over six days (23 Dec – 28 Dec) using the Osiris unit 2654. Additional hours were recorded on the 22 Dec and the 29 Dec; however, these data were removed to calculate 24-hour averages. The site is located near the centre of O'Mara Street (a residential area), approximately 100 m north-northwest of the coal rail line servicing the Carrington Coal Terminal and approximately 800 m southwest of the Carrington Coal Terminal coal stockpiles. Other industrial land is located more than 1 km to the northeast and east.

PM_1 concentrations over this period ranged from 1.24 to 2.65µgm^{-3} comprising approximately 4% of PM_{10} by mass.

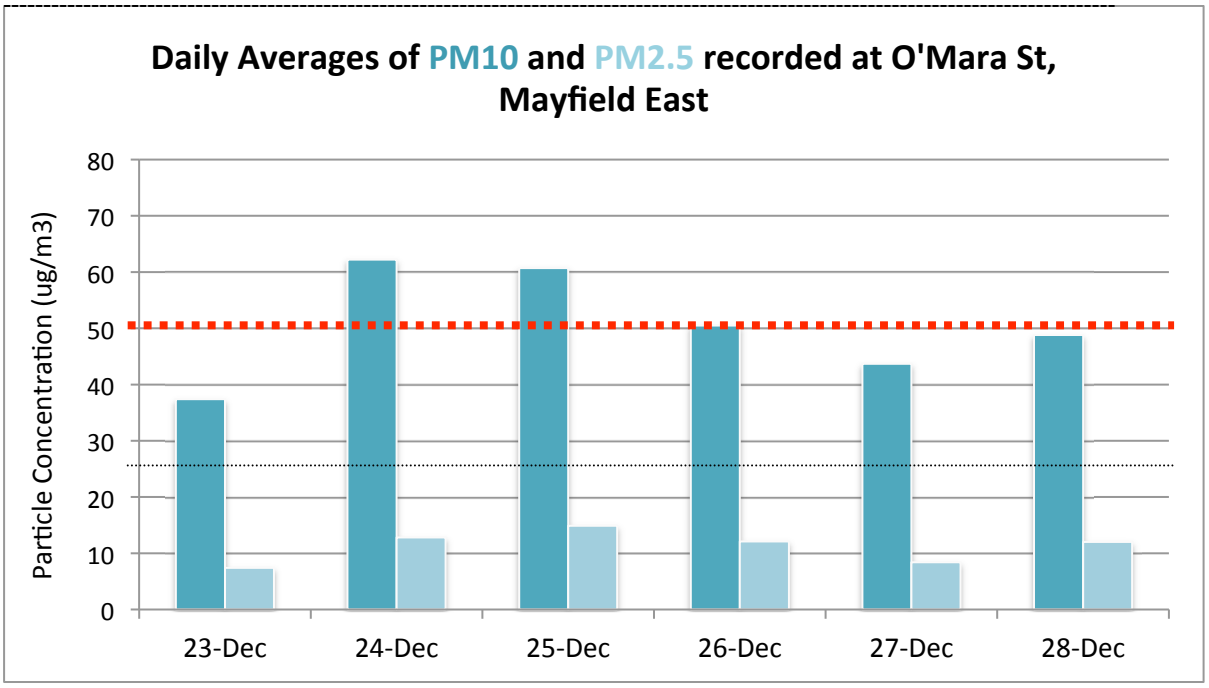


Figure 1: 24-hour averages at O'Mara Street, Mayfield East[3]

O'Mara Street, Mayfield East		
Date	**PM_{10}**	**$PM_{2.5}$**
23/12/2012	37.4	7.4
24/12/2012	62.2	12.8
25/12/2012	60.7	14.9
26/12/2012	50.5	12.1
27/12/2012	43.7	8.4
28/12/2012	48.8	12

Table 1: 24-hour averages at O'Mara Street, Mayfield East

[3] The heavy dashed red line signifies the NEPM PM_{10} standard and the light dashed black line indicates the NEPM $PM_{2.5}$ guideline.

Figure 1 and Table 1 above show that the PM_{10} NEPM standard (50 μgm^{-3} average per 24 hours) was exceeded for three of the six days of monitoring, with a fourth day producing a near exceedance (48.8 μgm^{-3}). The highest 24-hour PM_{10} average recorded was 62.2μgm^{-3}, on 24 Dec.

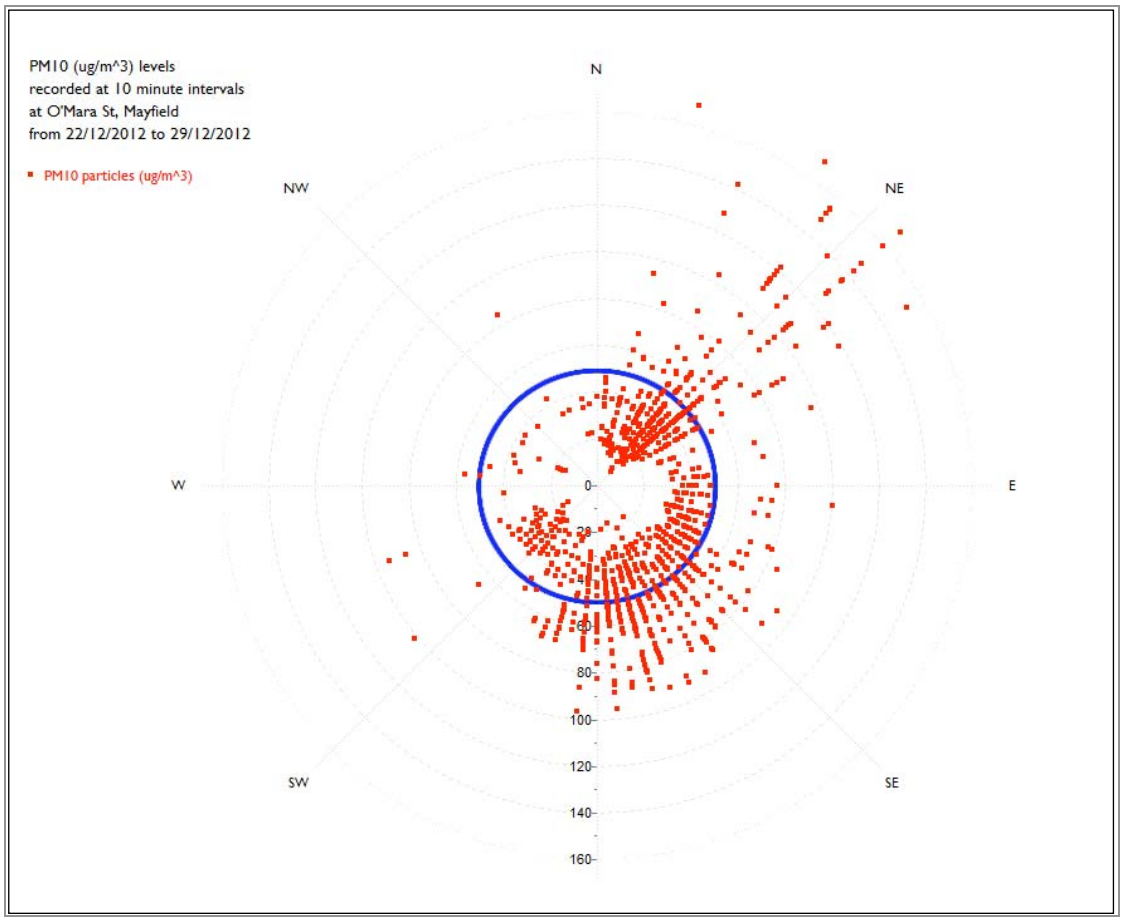


Figure 2: PM_{10} concentrations recorded at 10-minute intervals at O'Mara Street, Mayfield

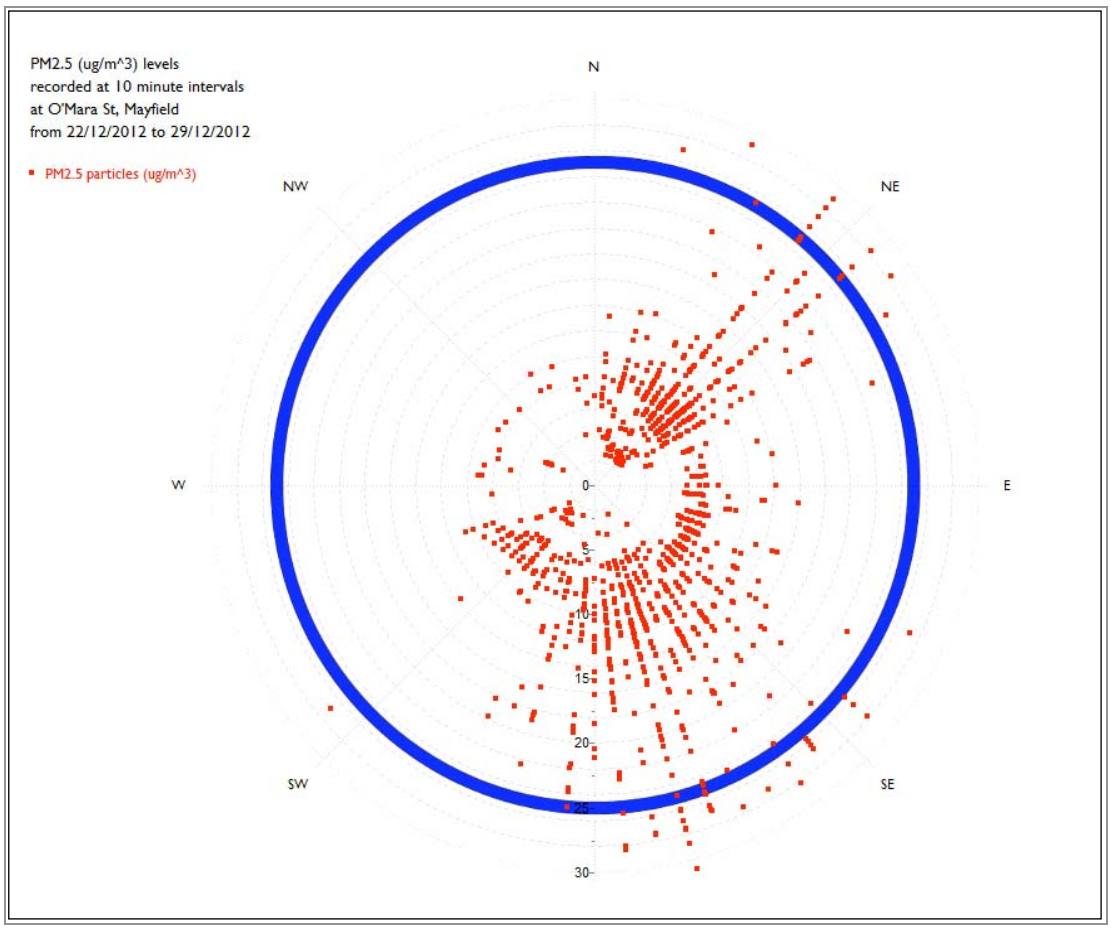


Figure 3: $PM_{2.5}$ concentrations recorded at 10-minute intervals at O'Mara Street, Mayfield

The above polar graphs indicate that wind was dominated by the north-northeast to southeast directions during this period and that the highest 10-minute average PM_{10} concentrations occurred with northeast winds. Airflows would have passed over coal stockpiles and industry to the northeast, which are likely to be siginificant sources of particles. A second group of higher 10-minute average PM_{10} concentrations occurred when winds were from the south-south-east, suggesting the coal rail line in this direction is a likely source. The city of Newcastle to the south-east is also a possible source.

A higher proportion of the $PM_{2.5}$ readings occurred from the south-southeast, indicating combustion activities from the city of Newcastle are a significant source of $PM_{2.5}$.

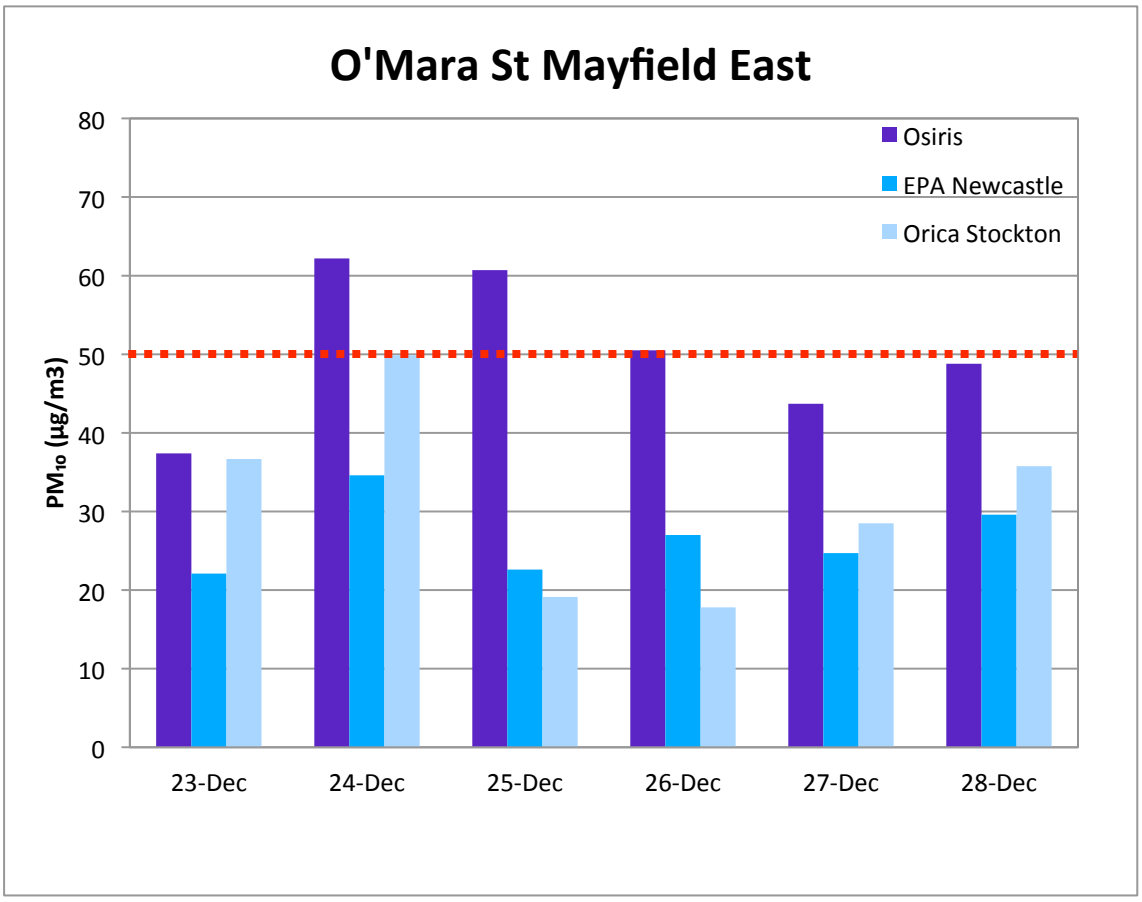


Figure 4: Comparative daily averages of PM_{10} for Orisis at O'Mara Street, Mayfield East, EPA at Cooks Hill and Orica at Stockton[4]

Date	Osiris Mayfield East PM_{10}	EPA Newcastle PM_{10}	Orica Stockton PM_{10}
23/12/2012	37.4	22.1	36.7
24/12/2012	62.2	34.6	49.9
25/12/2012	60.7	22.6	19.1
26/12/2012	50.5	27	17.8
27/12/2012	43.7	24.7	28.5
28/12/2012	48.8	29.6	35.8

Table 2: Comparative daily averages of PM_{10} for Orisis at O'Mara Street, Mayfield East, EPA at Cooks Hill and Orica at Stockton

The above table and graph shows that the site experienced substantially higher PM_{10} concentrations compared to the EPA monitor off Dumaresq St Cooks Hill for all days of the study period and almost three times the PM_{10} concentration on 25 Dec. The Orica monitor in Stockton showed comparable PM_{10} daily averages as the EPA monitor, with the exception of 23 Dec when PM_{10} concentrations were similar and on 24 Dec when the Stockton monitor showed a daily average of 49.9µgm^{-3} compared to the EPA average of 34.6µgm^{-3}. This Figure 4 suggests that PM_{10} pollution is generally much worse in this part of Mayfield compared to both Cooks Hill and Stockton, which may be due to

[4] The heavy dashed red line signifies the NEPM PM_{10} standard.

the relatively close proximity of the O'Mara St site to the Carrington Coal Terminal and coal rail corridors depending on wind direction.

Garrett Street, Carrington (Osiris monitor 2154)

This site was monitored using the Osiris unit 2154 from the 24 Dec to the 28 Dec (a total of five days). Additional hours were recorded on the 23 Dec and the 29 Dec however these data were removed to calculate 24-hour averages. The site is located at the northern end of Garrett Street (a residential area), approximately 800m due south of the Carrington Coal Terminal and associated coal rail lines; approximately 500m west of additional coal rail lines alongside the port. There is other industrial land to the north, south and west of the site.

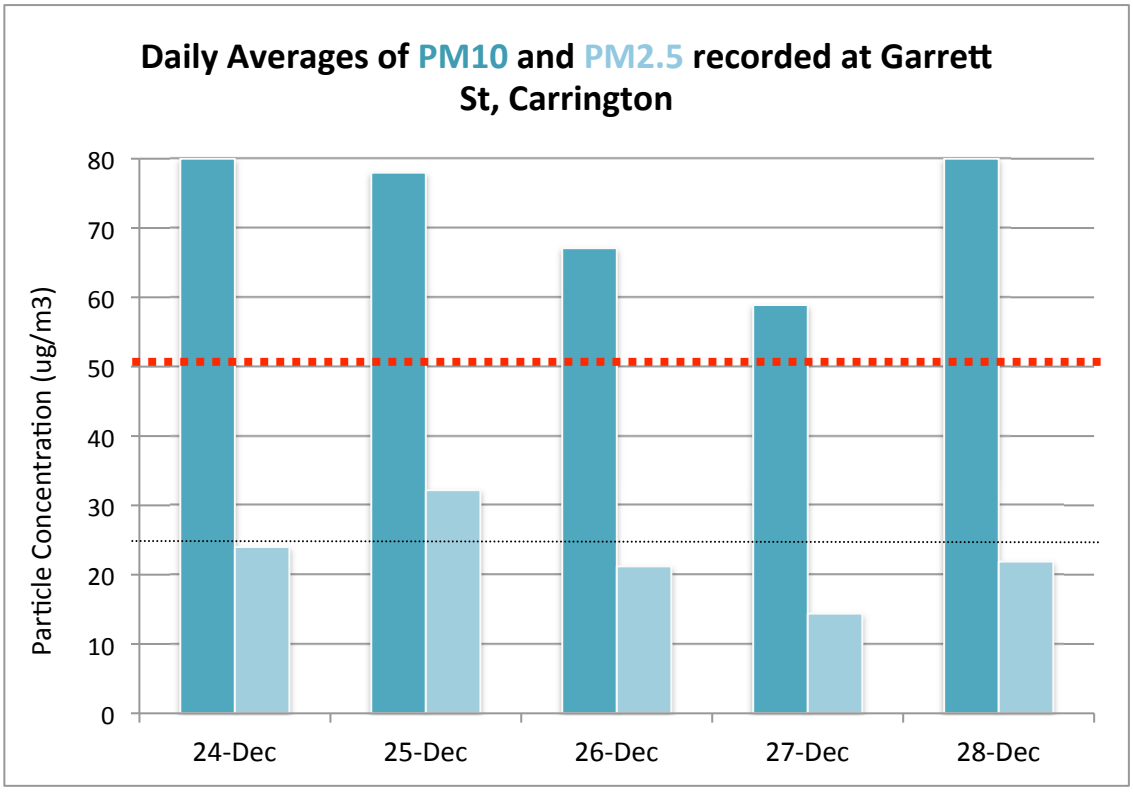


Figure 5: 24-hour averages at Garrett Street, Carrington[5]

Garrett St, Carrington		
Date	**PM_{10}**	**$PM_{2.5}$**
24/12/2012	80	24
25/12/2012	78	32.2
26/12/2012	67.1	21.2
27/12/2012	58.9	14.4
28/12/2012	80	21.9

Table 3: 24-hour averages at Garrett Street, Carrington

Figure 5 and Table 3 above show that the PM_{10} NEPM (50µgm^{-3} average per 24 hours) is reached or exceeded on all five days of monitoring and three days exceed the NEPM by more than 50 % (over 75µgm^{-3} per 24 hours). The reporting guideline for PM2.5 (25µgm^{-3} average per 24 hours) was

[5] The heavy dashed red line signifies the NEPM PM_{10} standard and the light dashed black line indicates the NEPM $PM_{2.5}$ guideline.

exceeded on one of the five days; however, three of the other days showed 24 hour averages over 20µgm^{-3}.

These results are the highest daily PM_{10} and $PM_{2.5}$ averages recorded in any of the 12 sites monitored during the study period, suggesting that Carrington residential areas have a substantial air quality problem.

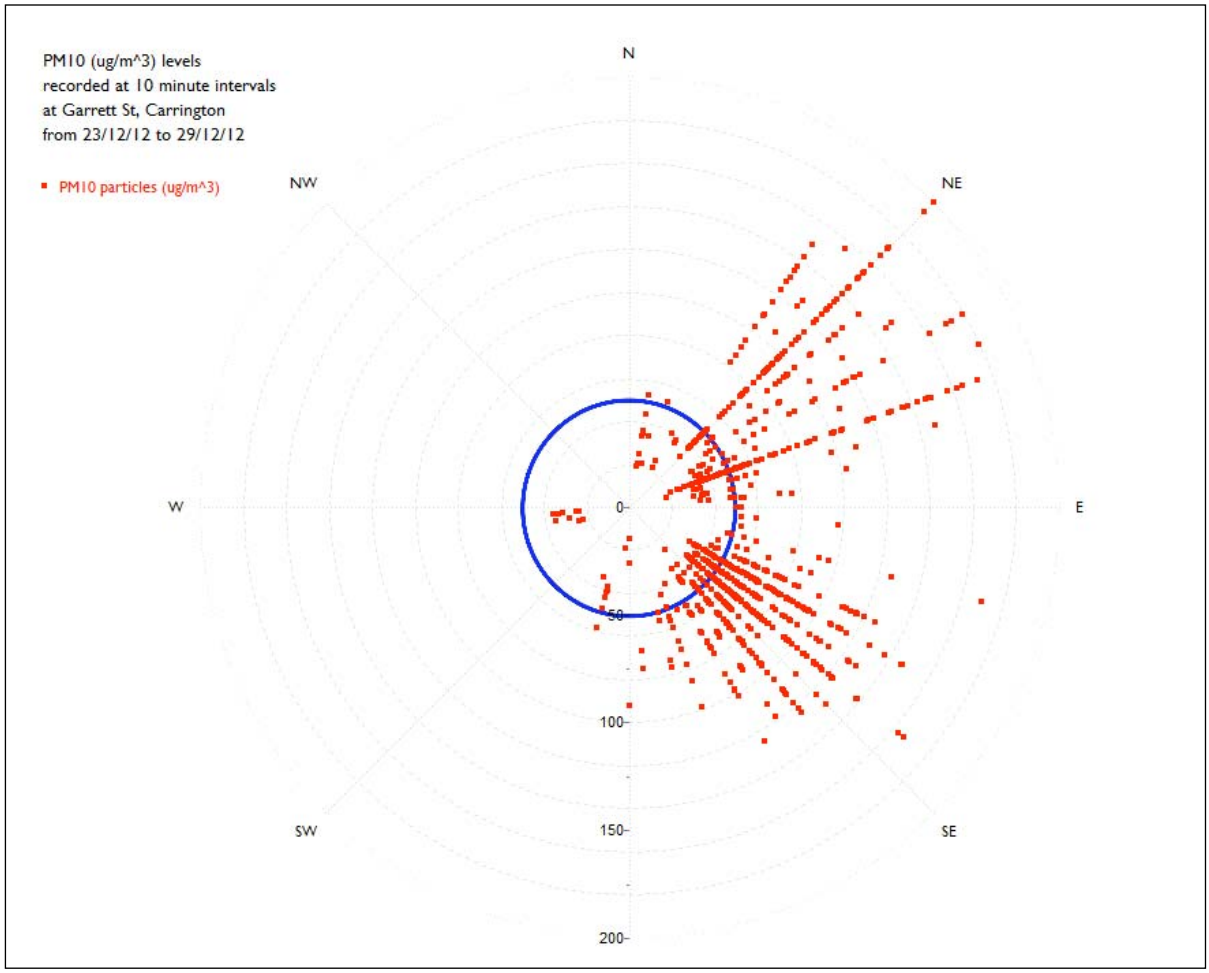


Figure 6: PM_{10} concentrations recorded at 10-minute intervals at Garrett Street, Carrington

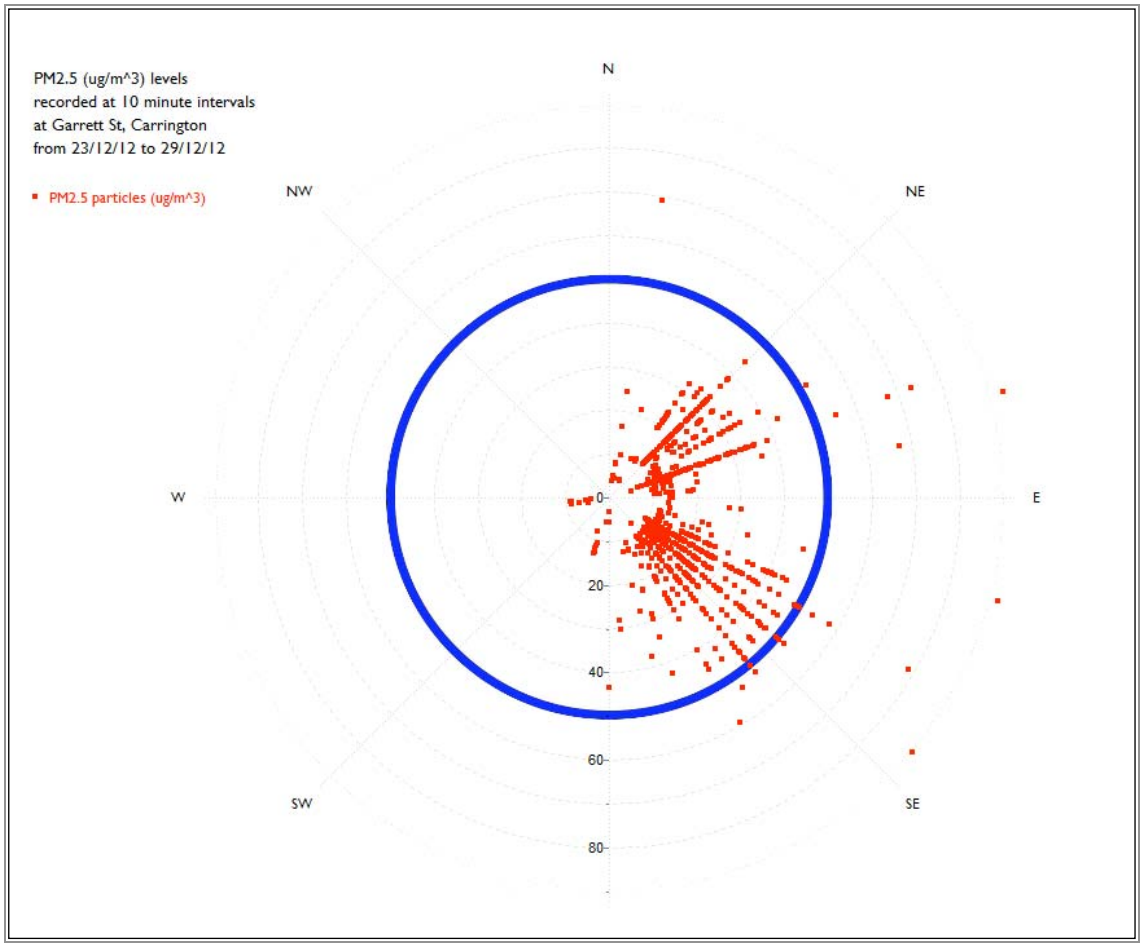


Figure 7: $PM_{2.5}$ concentrations recorded at 10-minute intervals at Garrett Street, Carrington

The polar graphs in Figures 6 and 7 above show the breakdown of PM_{10} and $PM_{2.5}$ concentration in relation to wind direction and speed. These graphs show that winds came almost exclusively from the east-northeast and east-southeast during this period. The recorded wind speed data showed that higher wind speeds occured from the east-southeast.

The polar graphs show that PM_{10} and $PM_{2.5}$ 10-minute concentrations are highest in air from the dominant wind directions, which are blowing over the port and other industrial infrastructure from the east-northeast and east-southeast (including parts of the Carrington Coal Terminal). The relatively higher concentrations of $PM_{2.5}$ occur in southeasterly winds, suggesting that combustion activities from this broad direction were a significant source of $PM_{2.5}$ during the monitoring period.

The PM_{10} graph shows that the majority of 10 minute average readings are well above 50μgm^{-3}, which translates into very high short-term peaks of PM_{10} within each 24 hour period.

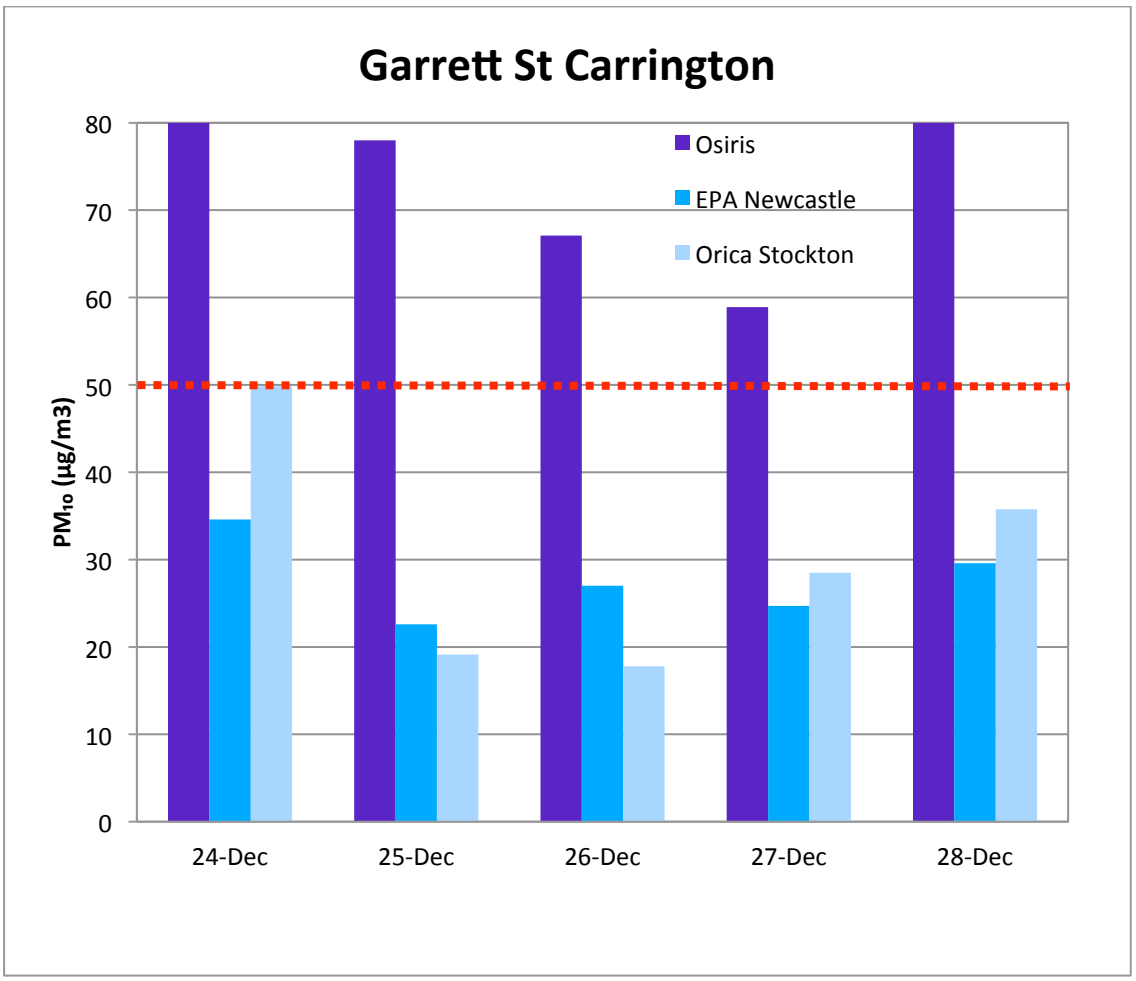


Figure 8: Comparative 24-hour averages of PM_{10} for Garrett Street, Carrington, EPA Cooks Hill and Orica Stockton[6]

Date	Osiris Carrington PM_{10}	EPA Newcastle PM_{10}	Orica Stockton PM_{10}
24/12/2012	80	34.6	49.9
25/12/2012	78	22.6	19.1
26/12/2012	67.1	27	17.8
27/12/2012	58.9	24.7	28.5
28/12/2012	80	29.6	35.8

Table 4: Comparative 24-hour averages of PM_{10} for Garrett Street, Carrington, EPA Cooks Hill and Orica Stockton

This graph and table above show that the site experienced PM_{10} concentrations at least twice as high as those recorded by the EPA monitor off Dumaresq St, Cooks Hill, for all days of the study period and almost three times the PM_{10} concentration on 25 Dec. The Orica monitor in Stockton showed comparable PM_{10} daily averages as the EPA monitor, with the exception of 24 Dec when PM_{10} concentrations were approximately $15\mu gm^{-3}$ higher at Stockton. This graph suggests that PM_{10} pollution is much worse at Carrington compared to both Cooks Hill and Stockton, which may be in part due to the relatively close proximity to the Carrington Coal Terminal, coal rail corridors and related port industrial activities.

[6] The heavy dashed red line signifies the NEPM PM_{10} standard.

Henry Street, Tighes Hill (Osiris monitor 2654)

This site was monitored using the Osiris unit 2654 from the 30 Dec to the 5 Jan (a total of seven days). Additional hours were recorded on the 29 Dec and the 6 Jan however these data were removed to calculate 24-hour averages. The site is located towards the eastern end of Henry Street (a residential area), approximately 300m southeast of the coal rail line servicing the Carrington Coal Terminal (no passenger train services use this line) and approximately 550m south-southwest of the Carrington Coal Terminal coal stockpiles.

24-hour PM_1 concentrations recorded at the site during this period range from 1.33 to 3µgm^{-3}. Average PM_1 is approximately 3.5% of PM_{10}.

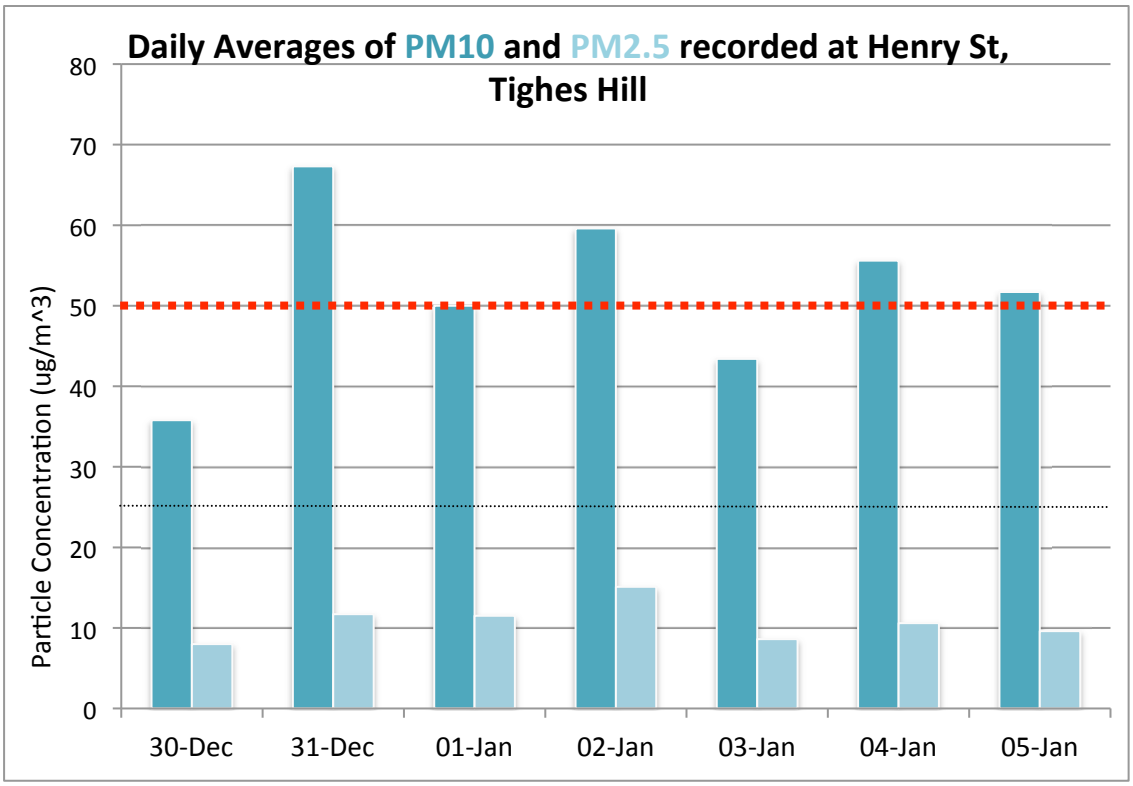


Figure 9: 24-hour averages at Henry Street, Tighes Hill[7]

Henry Street, Tighes Hill		
Date	**PM_{10}**	**$PM_{2.5}$**
30/12/2012	35.8	8
31/12/2012	67.3	11.7
1/01/2013	50	11.5
2/01/2013	59.6	15.1
3/01/2013	43.4	8.6
4/01/2013	55.6	10.6
5/01/2013	51.7	9.6

Table 5: 24-hour averages at Henry Street, Tighes Hill

Figure 9 and Table 5 show that the PM_{10} NEPM (50µgm^{-3} average per 24 hours) is reached or exceeded on five of the seven days of monitoring and one exceedance reached beyond 65µgm^{-3}.

[7] The heavy dashed red line signifies the NEPM PM_{10} standard and the light dashed black line indicates the NEPM $PM_{2.5}$ guideline.

These results are the second highest daily PM_{10} averages recorded in any of the 12 sites monitored during the study period, suggesting that Tighes Hill residential areas have a substantial air quality problem.

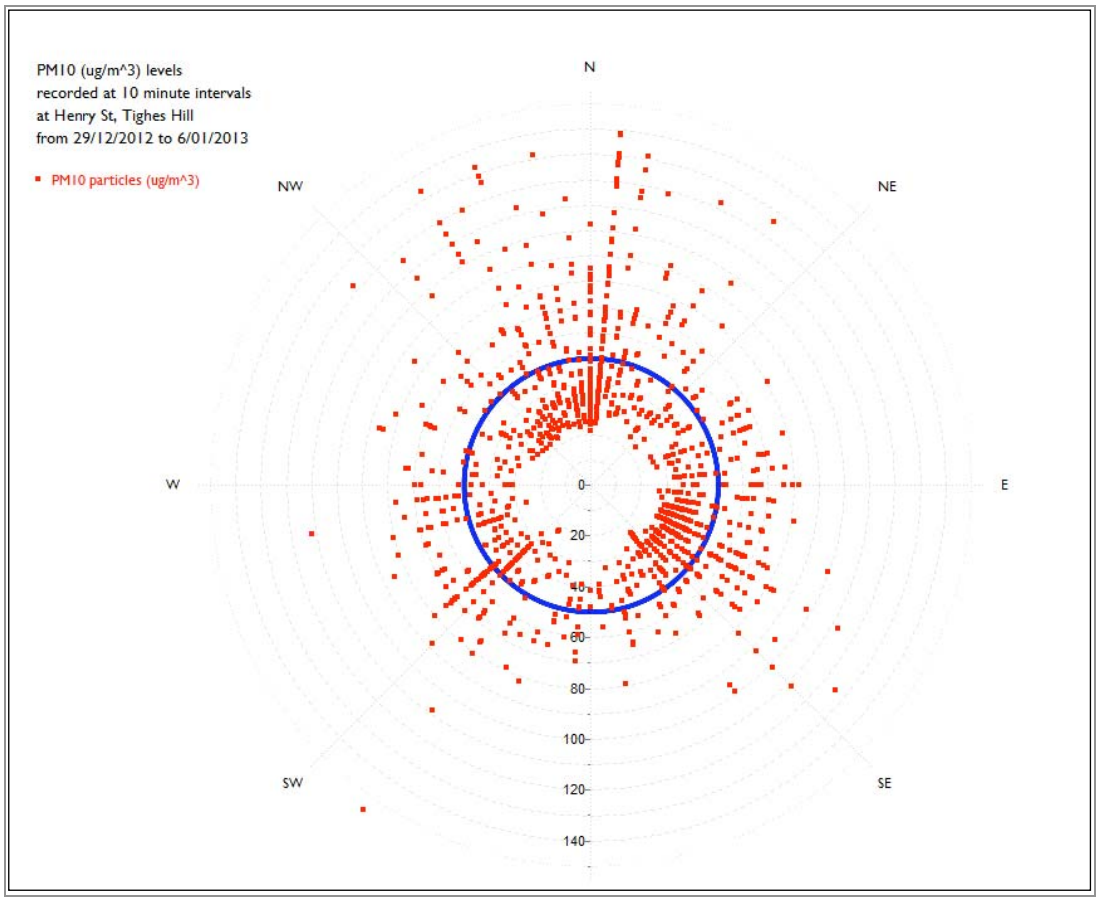


Figure 10: PM_{10} concentrations recorded at 10-minute intervals at Henry Street, Tighes Hill

The polar graphs in Figures 10 and 11 above show the breakdown of PM_{10} and $PM_{2.5}$ concentration in relation to wind direction and speed. This indicates that wind generally came from all directions during this period. The higher 10-minute average PM_{10} and $PM_{2.5}$ concentrations come from most wind directions, but slightly more from the northern quadrant, which includes substantial areas of industrial land including the Carrington Coal Terminal.

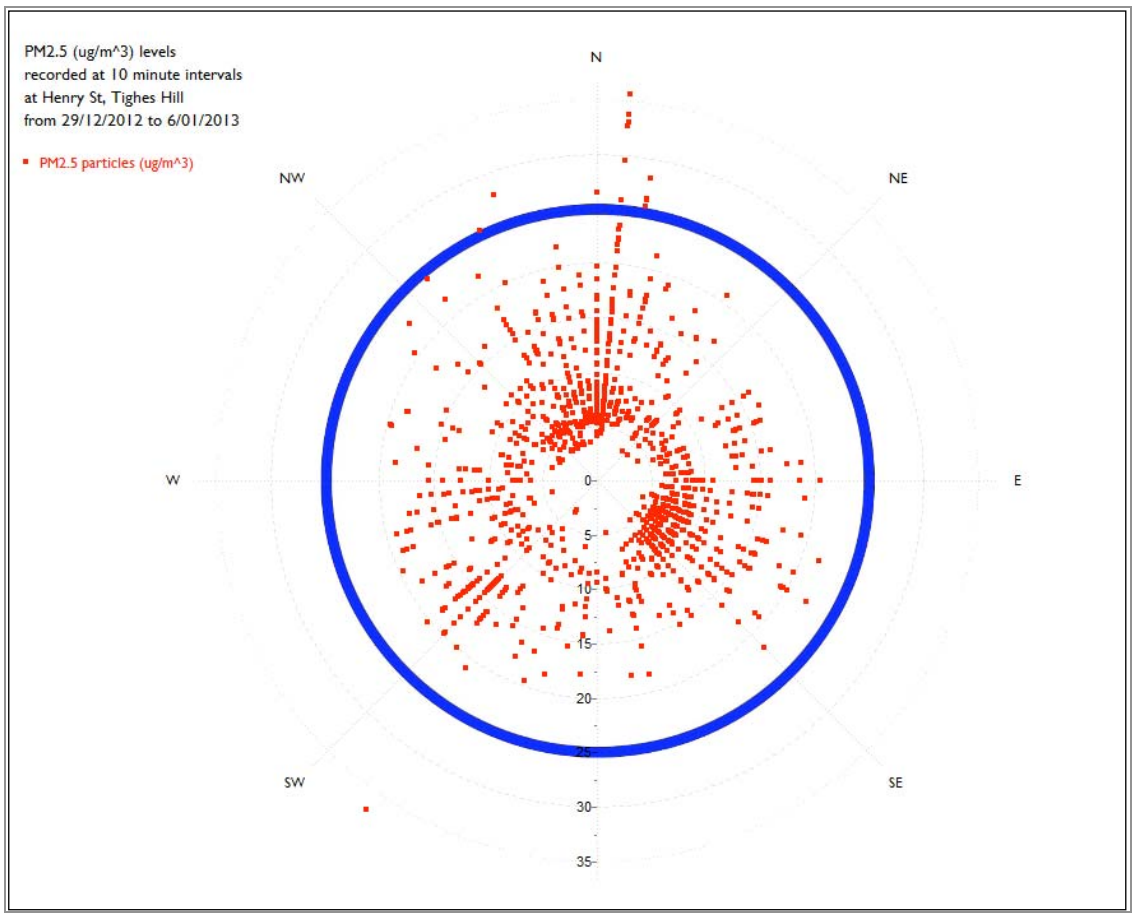


Figure 11: $PM_{2.5}$ concentrations recorded at 10-minute at Henry Street, Tighes Hill

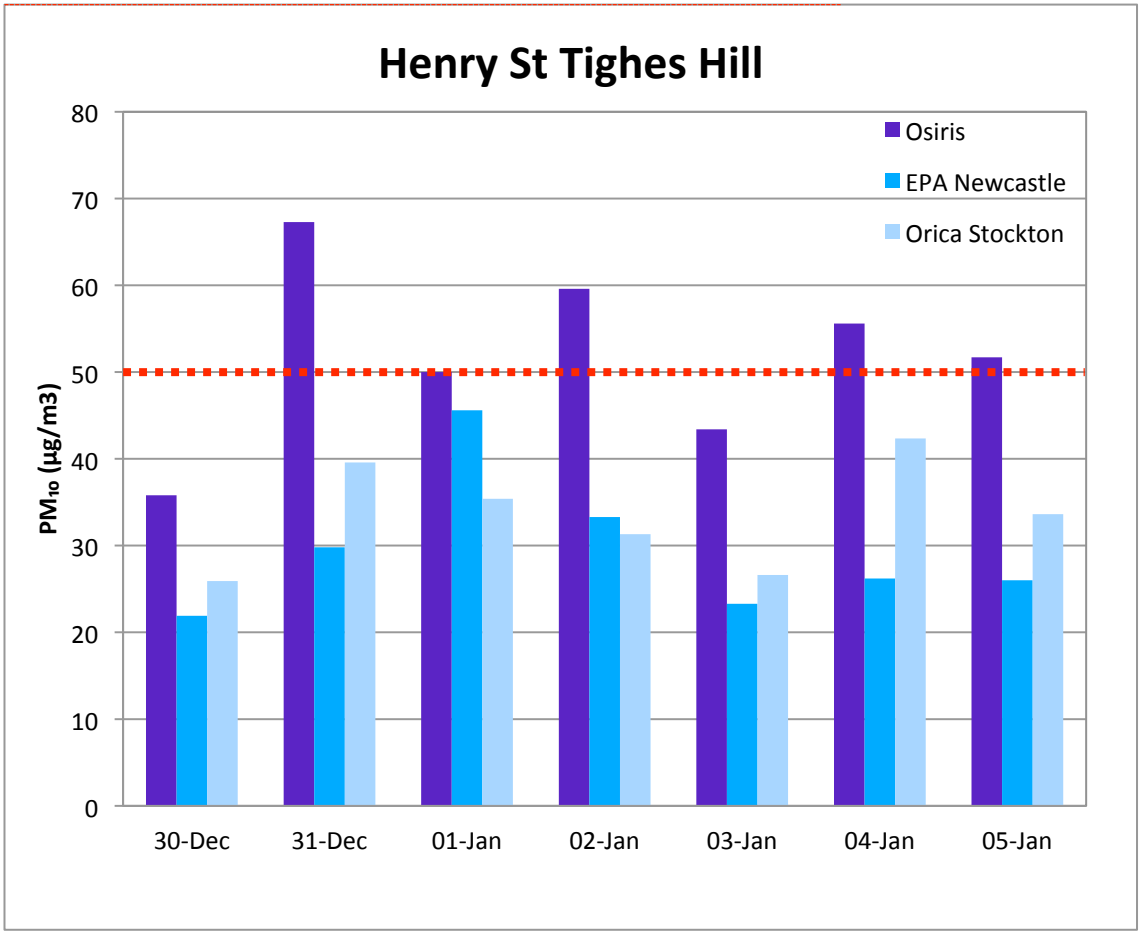


Figure 12: Comparative 24-hour averages of PM_{10} recorded for Orisis at Henry Street, Tighes Hill, EPA at Cooks Hill and Orica at Stockton[8]

Date	Osiris Tighes Hill PM_{10}	EPA Newcastle PM_{10}	Orica Stockton PM_{10}
30/12/2012	35.8	21.9	25.9
31/12/2012	67.3	29.8	39.6
1/01/2013	50	45.6	35.4
2/01/2013	59.6	33.3	31.3
3/01/2013	43.4	23.3	26.6
4/01/2013	55.6	26.2	42.3
5/01/2013	51.7	26	33.6

Table 6: Comparative 24-hour averages of PM_{10} recorded for Orisis at Henry Street, Tighes Hill, EPA at Cooks Hill and Orica at Stockton

This data set shows that the site experienced substantially higher PM_{10} concentrations than the EPA monitor off Dumaresq St Cooks Hill for most days of the study period, with the exception of 12 Dec when the daily averages were within approximately 5µgm^{-3} of each other. The Orica monitor in Stockton generally showed PM_{10} daily averages at intermediate levels between the Henry St site and the EPA monitoring site. This trend of increasing PM_{10} pollution at Stockton and Tighes Hill

[8] The heavy dashed red line signifies the NEPM PM_{10} standard.

corresponds with the decreasing distance between the monitoring station and industrial land, including coal infrastructure.

Maitland Road, Hexham (Osiris monitor 2654)

This site was monitored using the Osiris unit 2654 from the 18 Dec to the 20 Dec (a total of three days). Additional hours were recorded on the 17 Dec and the 21 Dec; however, these data were removed to calculate 24-hour averages. The site is a residential lot located between the rail corridor to the west and Maitland Road/New England Highway to the east. The rail corridor is approximately 50 m west of the site. The EPA Beresfield monitor is approximately 6.7 km to the north-northeast of the site.

PM_1 24-hour averages ranged from 1.55 to 2.07µgm^{-3} and make up about 4% of PM_{10}.

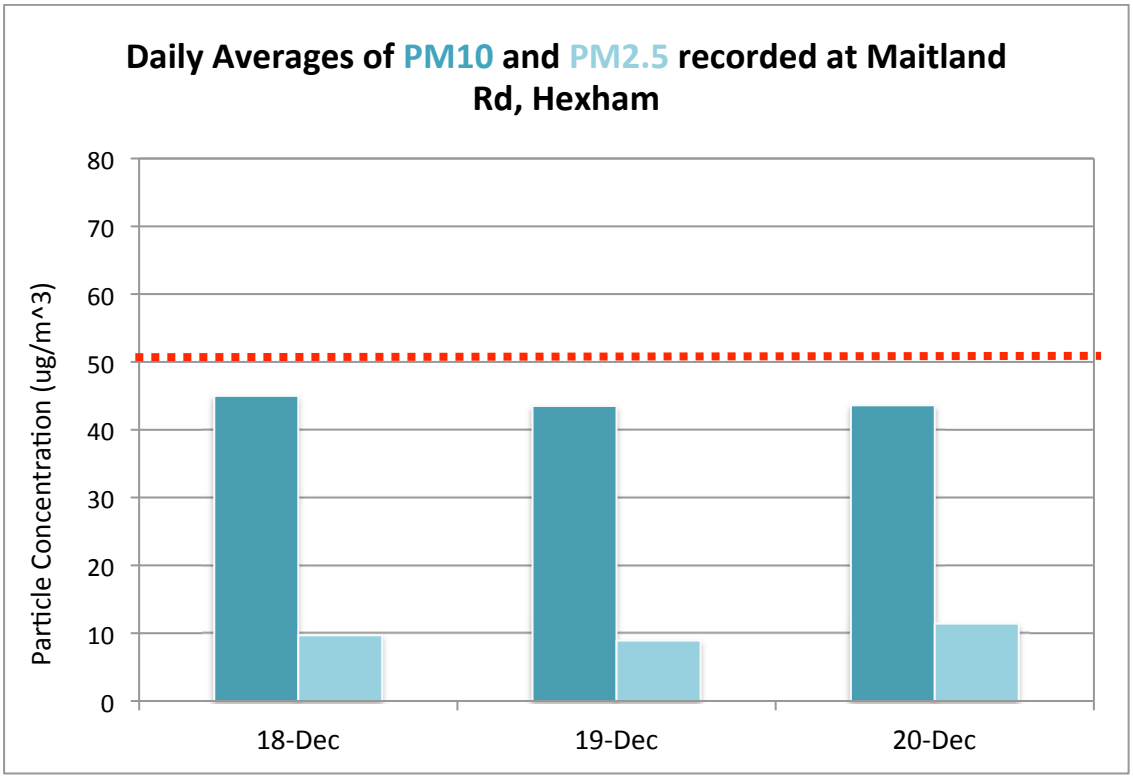


Figure 13: 24-hour averages at Maitland Road, Hexham[9]

Maitland Rd, Hexham		
Date	**PM_{10}**	**$PM_{2.5}$**
18/12/2012	45	9.7
19/12/2012	43.5	8.9
20/12/2012	43.6	11.4

Table 7: 24-hour averages at Maitland Road, Hexham

Table 7 and Figure 13 above show that the daily PM_{10} averages are consistently in the 40-50µgm^{-3} range and that $PM_{2.5}$ is consistently around the 10µgm^{-3} level during the monitoring period. These results for average PM_{10} and $PM_{2.5}$ concentrations show the least variability between days for all 11 sites monitored during the study period.

[9] The heavy dashed red line signifies the NEPM PM_{10} standard.

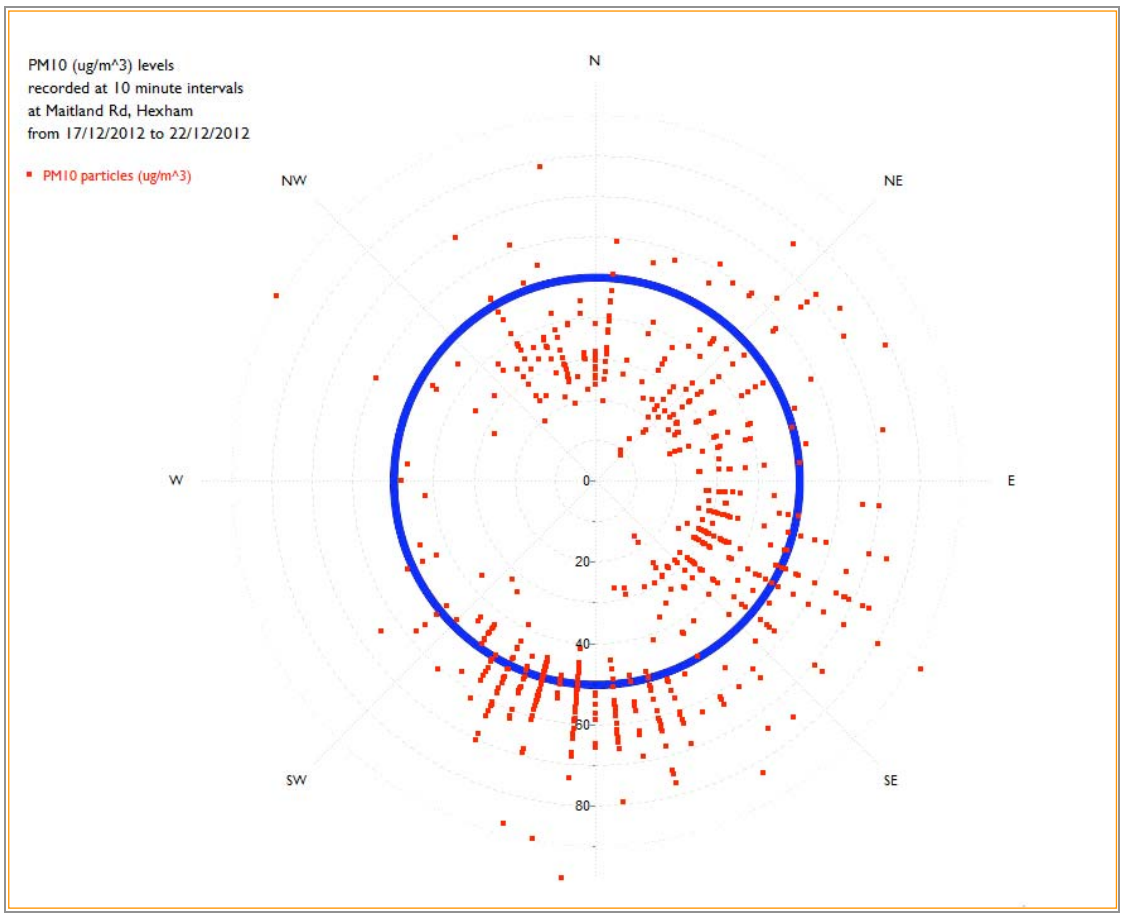


Figure 14: PM_{10} concentrations recorded at 10-minute intervals at Maitland Road, Hexham

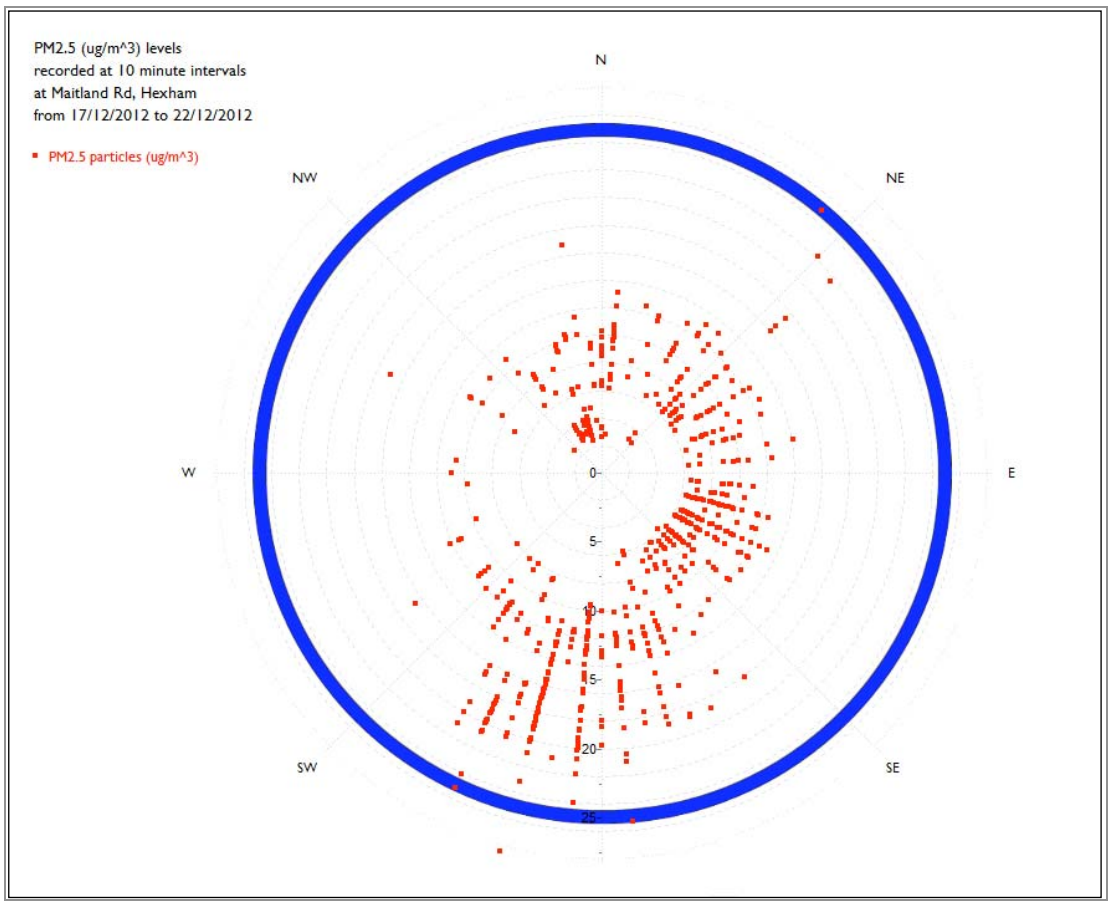


Figure 15: $PM_{2.5}$ concentrations recorded at 10-minute intervals at Maitland Road, Hexham

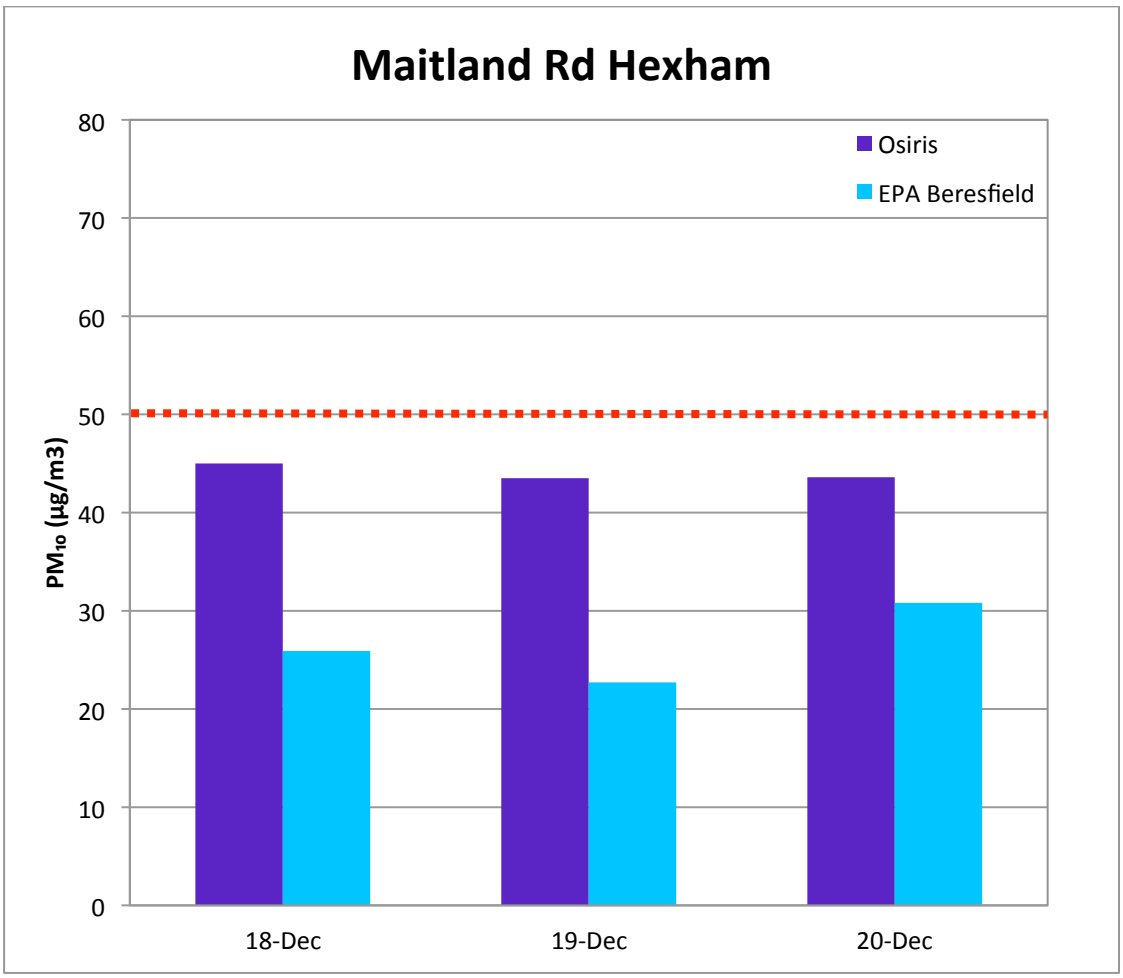


Figure 16: Comparative 24-hour averages of PM_{10} for Osiris at Maitland Road, Hexham and EPA at Beresfield[10]

Date	Osiris Hexham PM_{10}	EPA Beresfield PM_{10}
18/12/2012	45	25.9
19/12/2012	43.5	22.7
20/12/2012	43.6	30.8

Table 8: Comparative 24-hour averages of PM_{10} for Osiris at Maitland Road, Hexham and EPA at Beresfield

Figure 16 and Table 8 above compare the PM_{10} and $PM_{2.5}$ daily averages between the Hexham site and the EPA Beresfield monitor. Average PM_{10} concentrations at Hexham are more than double those at Beresfield on 18 Dec, a trend which diminishes steadily until 20 Dec when the Beresfield readings are slightly higher. $PM_{2.5}$ daily averages are similar for both sites throughout the monitoring period.

Cumberland Road, East Maitland (Osiris monitor 2154)

This site was monitored using the Osiris unit 2154 from the 30 Dec to the 05 Jan (a total of seven days). Additional hours were recorded on the 29 Dec and the 06 Jan; however, these data were removed to calculate 24-hour averages. The site is located 400 m northeast of the rail line and is

[10] The heavy dashed red line signifies the NEPM PM_{10} standard.

situated within a residential area with medium density housing to the south and agricultural land use to the north. The EPA Beresfield monitor is approximately 9 km to the southeast of the site.

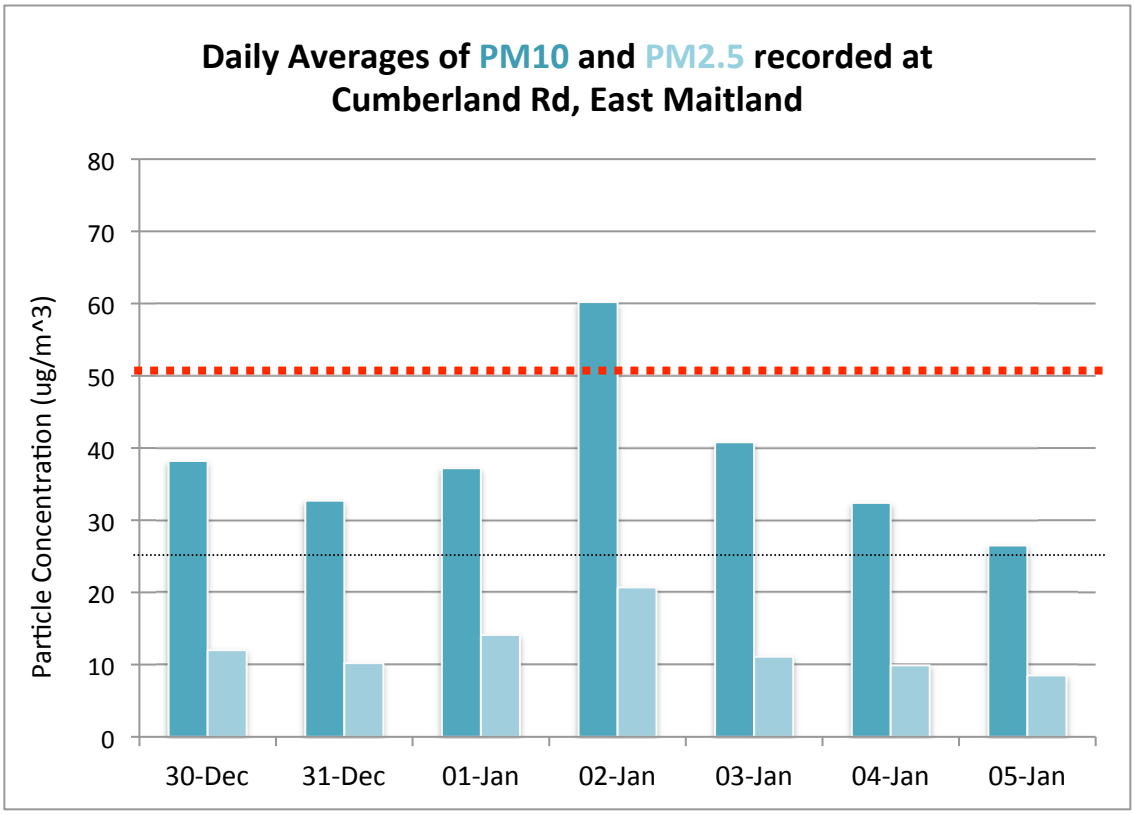


Figure 17: 24-hour averages at Cumberland Road, East Maitland[11]

Cumberland Rd, East Maitland		
Date	**PM_{10}**	**$PM_{2.5}$**
30/12/2012	38.2	12
31/12/2012	32.7	10.2
1/01/2013	37.2	14.1
2/01/2013	60.2	20.7
3/01/2013	40.8	11.1
4/01/2013	32.4	9.9
5/01/2013	26.5	8.5

Table 9: 24-hour averages at Cumberland Road, East Maitland

Figure 17 and Table 9 above shows that the PM_{10} NEPM (50µgm^{-3} average per 24 hours) was exceeded on 02 Jan all five days of monitoring. Five of the remaining six days showed PM_{10} concentrations in the range of 30-40.8µgm^{-3}, 60-80% of the NEPM level.

[11] The heavy dashed red line signifies the NEPM PM_{10} standard and the light dashed black line indicates the NEPM $PM_{2.5}$ guideline.

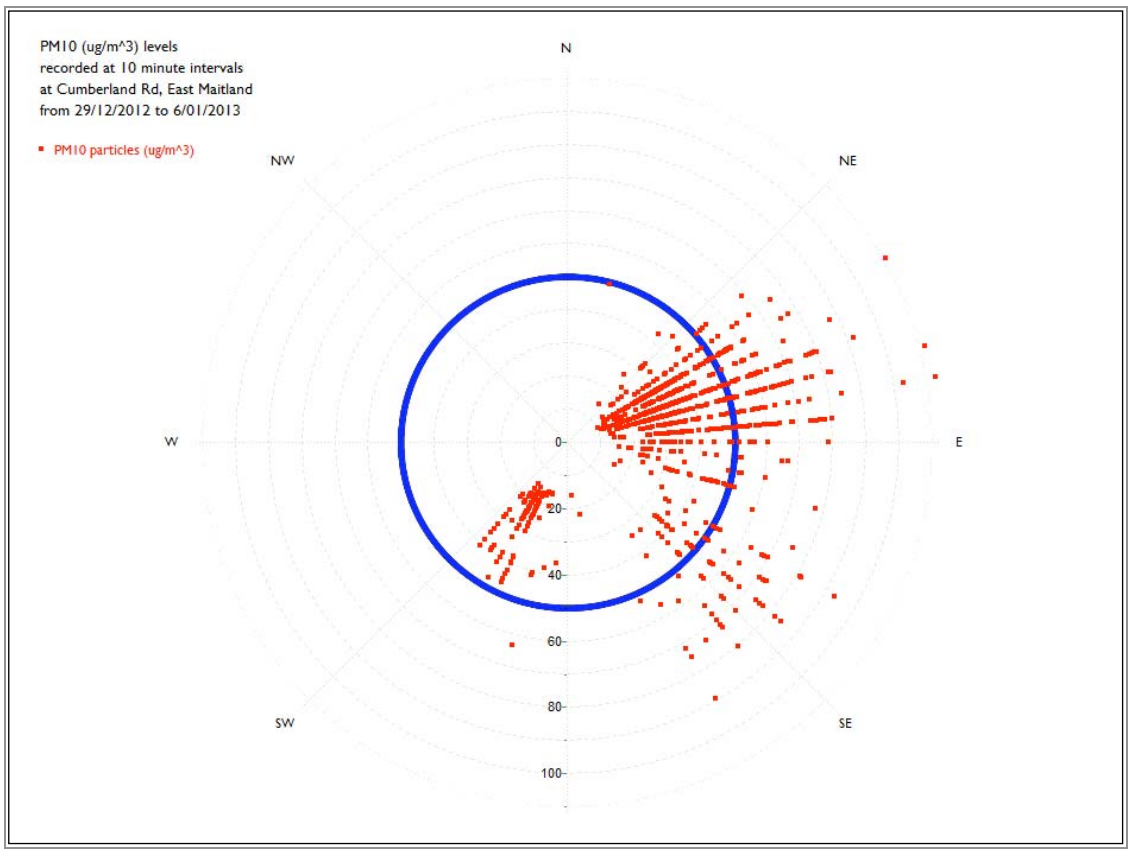


Figure 18: PM_{10} concentrations recorded at 10-minute at Cumberland Road, East Maitland

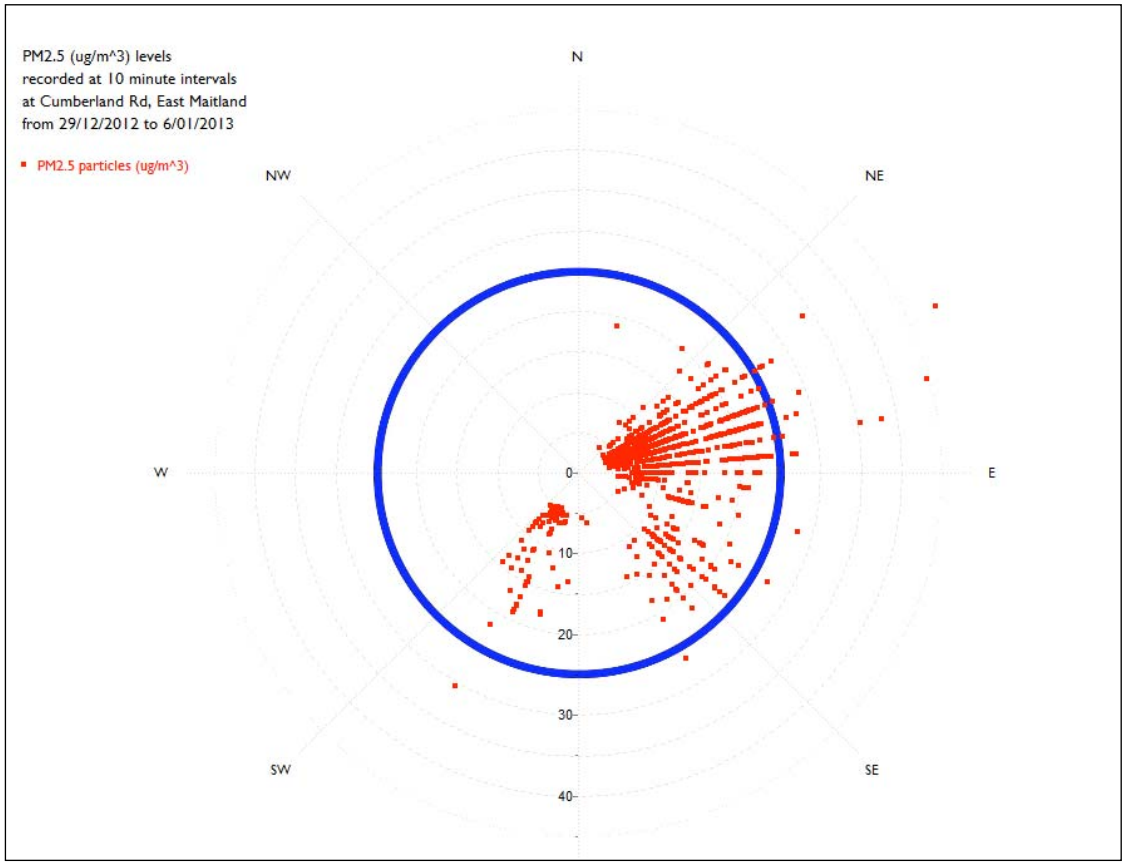


Figure 19: $PM_{2.5}$ concentrations recorded at 10-minute intervals at Cumberland Road, East Maitland

The polar graphs above show that the distribution patterns of PM_{10} and $PM_{2.5}$ sources are similar. Winds were dominated by east-northeast and south-southwest winds. No winds were recorded from the west or north. Higher 10-minute PM_{10} concentrations occur when the wind is from the northeast to southeast directions.

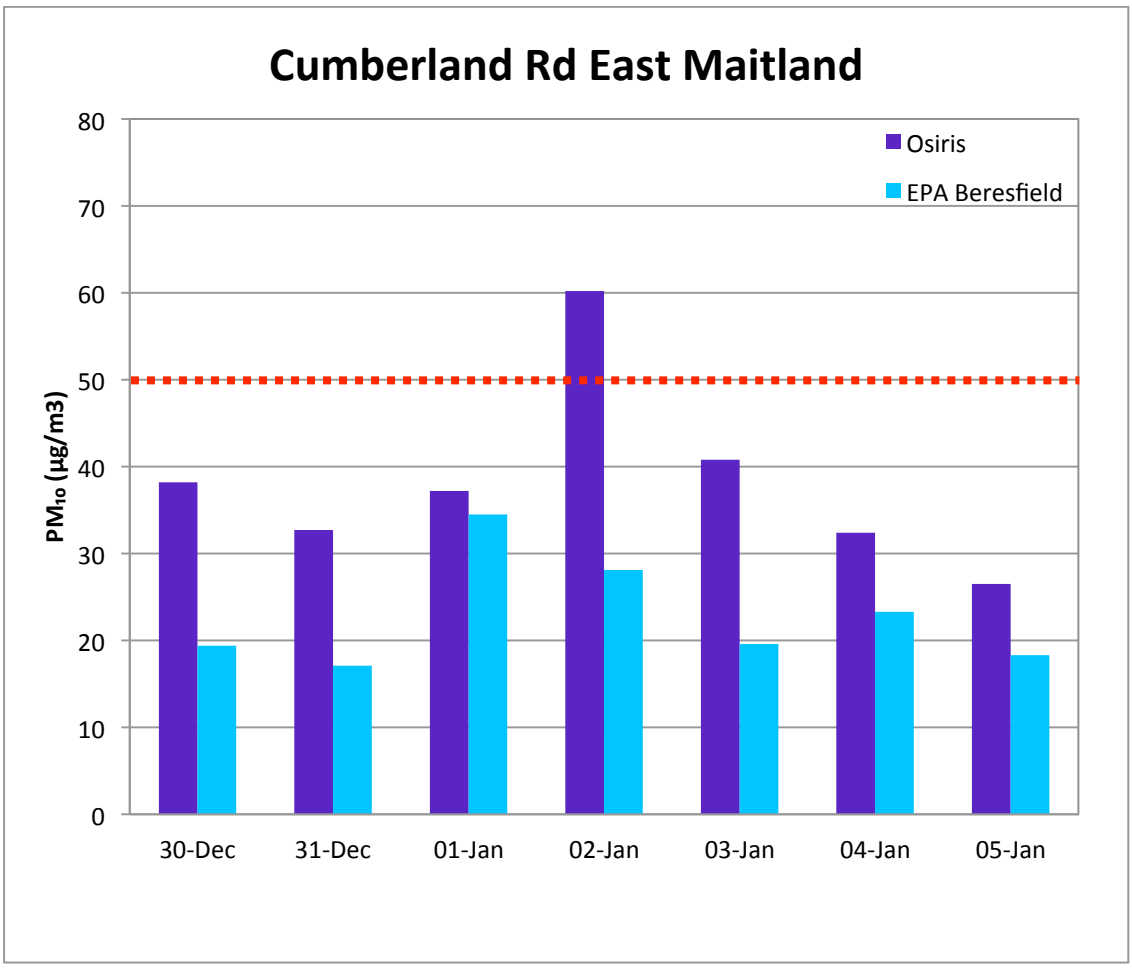


Figure 20: Comparative 24-hour averages of PM_{10} for Osiris at Cumberland Road, East Maitland and EPA at Beresfield[12]

Date	Osiris East Maitland PM_{10}	EPA Beresfield PM_{10}
30/12/2012	38.2	19.4
31/12/2012	32.7	17.1
1/01/2013	37.2	34.5
2/01/2013	60.2	28.1
3/01/2013	40.8	19.6
4/01/2013	32.4	23.3
5/01/2013	26.5	18.3

Table 10: Comparative 24-hour averages of PM_{10} for Osiris at Cumberland Road, East Maitland and EPA at Beresfield

[12] The heavy dashed red line signifies the NEPM PM_{10} standard.

The above graph and table shows that 24-hour average PM_{10} concentrations are consistently much higher than the EPA monitor in Beresfield. On 30-31 Dec and 02-03 Jan, the PM_{10} concentrations were approximately double those recorded in Beresfield.

Discussion and Recommendations

Air Quality

The results from suburbs close to the Port of Newcastle show that the closer that a monitor is located to industrial infrastructure, including coal loaders and coal train lines, the worse the air quality for both PM_{10} and $PM_{2.5}$. This trend is confirmed by a comparison with the permanent EPA air quality monitor in Cooks Hill, where PM_{10} levels are typically 25-50% of those recorded in Mayfield, Mayfield East, Tighes Hill and Carrington. The permanent Orica-funded monitor in Stockton also shows this trend. The EPA monitor is approximately three kilometres away from the nearest source of coal at Carrington, but is exposed to a similar amount of urban vehicle traffic and the Stockton monitor is approximately 1.6 km from the nearest coal infrastructure on Carrington.

A similar trend is observed for the Lower Hunter sites from Hexham to Lochinvar; where the Osiris monitoring sites recorded PM_{10} daily averages that were appreciably higher than the PM_{10} daily averages at the closest EPA site at Beresfield. Beresfield is located further from the coal rail corridor than the sites at Hexham, Thornton, East Maitland and Lochinvar.

The 24 hour PM_{10} averages observed in this monitoring study demonstrate that airborne particle pollution was very high in the inner city localities during the brief period of monitoring, especially areas around the monitored sites in Carrington, Tighes Hill and Mayfield East, and to a lesser extent Mayfield. The PM_{10} NEPM was reached or exceeded on:

- all five monitoring days at Carrington;
- five in seven days at Tighes Hill;
- three in six days at Mayfield East;
- one in two days at Charles St East Maitland;
- one in seven days at Cumberland St East Maitland (despite absence of northwesterly winds coming across the rail corridor during monitoring); and
- one in seven days at Winders Road, Lochinvar.

In a brief period of monitoring, the objective of limiting exceedances of the PM_{10} NEPM to five days per year was not met at Carrington and Tighes Hill and unlikely to be met over 12 months at Mayfield East. At many of the 11 sites analysed, including those that did not register PM_{10} exceedances, the daily averages were regularly 60-90% of the $50\mu gm^{-3}$ NEPM standard. The broad data set across all 11 sites suggests that these localities have an appreciable air quality problem.

The ranges of monitoring conditions experienced during the study period from 5 Dec to 5 Jan are expected to be indicative of summer conditions. It is therefore reasonable to conclude that similar PM_{10} and $PM_{2.5}$ patterns would be continue into January and February; although the heavy and frequent rainfall in and around Newcastle and the lower Hunter this summer would serve to pull airborne particulate matter out of suspension.

The monitoring sites are broadly representative of the residential areas in which they are located, and therefore serve as an indicator of the air quality of that particular locality for typical summer months. The brief monitoring periods were adequate to demonstrate that high PM_{10} levels are normal for the localities monitored, particularly those in close proximity to the Port of Newcastle (Mayfield, Tighes Hill and Carrington).

Sources of Air Pollution

This study does not attempt to identify the chemical composition of the particulate matter observed. For that task, chemical species of particles must be characterised by processes such as mass spectrophotometry, which is very costly. We note that a fine particle characterisation study is currently being conducted by OEH, ANSTO and the University of NSW in the Upper Hunter and we eagerly await these results and look forward to such a study being carried out in the Lower Hunter and Newcastle.

Coal exporting is by far the biggest industry in the Port of Newcastle in terms of land area, volume of cargo handled and revenue and the substantial dust emissions from stockpiles, loaders and trains have been well catalogued over many years by industry and the public. Dust generated by coal transport and export is a substantial contributor to the overall levels of air pollution around the Port of Newcastle and along coal rail lines in the Lower Hunter.

There are instances across the 11 sites analysed where the prevailing winds during the monitoring period did not pass over dust sources such as coal infrastructure including stockpiles, loaders, rail lines and coal train wagons before they reached the monitor. As a result, it is reasonable to conclude that less dust would be transported to the monitor at these times, likely resulting in a decrease in particle concentrations compared to when prevailing winds are carrying dust to the monitoring sites. In this context, sites which experienced light winds that did not travel over coal sources could be regarded as experiencing better air quality than might otherwise have been observed had coal dust been blown to the site from local sources.

Future Studies

More detailed investigations, including longer term ambient air quality monitoring and particle characterisation studies should be carried out in the Lower Hunter to further explore air quality issues affecting this region. Independent research needs to be commissioned to establish the sources of particle pollution in the Hunter's coal corridor. To date, there have been no studies to conclusively identify the proportion of the particle pollution close to the coal corridor that is coal dust, or the precise source/s of the coal dust (uncovered wagons and stockpiles, coal handling, ballast, etc). Such a study will require counting and characterising fine and ultrafine (sub-micron) particles and is an essential prerequisite to the assessment of any development that will add to particle pollution in the Hunter. Such studies would serve as a robust 'background' on which to model and assess additional sources of pollution and cumulative impacts of expanding industry.

References

Colagiuri, R. Cochrane, J. Girgis, S. 2012, 'Health and Social Harms of Coal Mining in Local Communities: Spotlight on the Hunter Region', Beyond Zero Emissions, Melbourne. Available: http://media.beyondzeroemissions.org/coal_health_Report_FINAL.pdf (accessed 4th March, 2013).

Appendix A: 24 hour PM_{10} and $PM_{2.5}$ averages for Osiris, EPA and Stockton monitoring sites

Location	Date	Osiris PM_{10} (ugm^{-3})	EPA Wallsend PM_{10} (ugm^{-3})	EPA Newcastle PM_{10} (ugm^{-3})	EPA Beresfield PM_{10} (ugm^{-3})	Orica Stockton PM_{10} (ugm^{-3})
Upfold St,	10/12/2012	23.6	5	14.2	7.5	10.9
Mayfield	11/12/2012	47.7	10.3	21.8	14.7	18.1
	12/12/2012	32.6	8.1	14.7	15	25.8
	13/12/2012	31.5	11.1	15.7	16.3	32.0
	14/12/2012	42.8	16	28.2	15.9	36.5
	15/12/2012	47.7	19.7	29.5	22.2	36.1
Crebert St,	11/12/2012	52.4	10.3	21.8	14.7	18.1
Mayfield	12/12/2012	29.1	8.1	14.7	15	25.8
	13/12/2012	32.3	11.1	15.7	16.3	32.0
	14/12/2012	45.6	16	28.2	15.9	36.5
	15/12/2012	48.8	19.7	29.5	22.2	36.1
Maitland Rd,	18/12/2012	45	24	26.2	25.9	29.1
Hexham	19/12/2012	43.5	20.8	27	22.7	38.2
	20/12/2012	43.6	22.6	30.9	30.8	38.6
Deschamps Cl,	18/12/2012	33.8	24	26.2	25.9	29.1
Thornton	19/12/2012	41.3	20.8	27	22.7	38.2
	20/12/2012	37.2	22.6	30.9	30.8	38.6
Charles St, East	19/12/2012	35.9	20.8	27	22.7	38.2
Maitland	20/12/2012	51.7	22.6	30.9	30.8	38.6
O'Mara St, Mayfield	23/12/2012	37.4	11.4	22.1	14.6	36.7
East	24/12/2012	62.2	19.2	34.6	20.7	49.9
	25/12/2012	60.7	9.7	22.6	12.2	19.1
	26/12/2012	50.5	13.3	27	19.4	17.8
	27/12/2012	43.7	15.2	24.7	21.3	28.5
	28/12/2012	48.8	18	29.6	25.5	35.8
Park Ave,	23/12/2012	30	11.4	22.1	14.6	36.7
Kotara	24/12/2012	44.3	19.2	34.6	20.7	49.9
	25/12/2012	40.5	9.7	22.6	12.2	19.1
	26/12/2012	40.8	13.3	27	19.4	17.8
	27/12/2012	32.5	15.2	24.7	21.3	28.5
	28/12/2012	42.2	18	29.6	25.5	35.8
Garrett St,	24/12/2012	80	19.2	34.6	20.7	49.9
Carrington	25/12/2012	78	9.7	22.6	12.2	19.1
	26/12/2012	67.1	13.3	27	19.4	17.8
	27/12/2012	58.9	15.2	24.7	21.3	28.5
	28/12/2012	80	18	29.6	25.5	35.8

Cumberland Rd, East Maitland	30/12/2012	38.2	14.8	21.9	19.4	25.9
	31/12/2012	32.7	17.9	29.8	17.1	39.6
	1/01/2013	37.2	25.2	45.6	34.5	35.4
	2/01/2013	60.2	19.2	33.3	28.1	31.3
	3/01/2013	40.8	13.8	23.3	19.6	26.6
	4/01/2013	32.4	18.8	26.2	23.3	42.3
	5/01/2013	26.5	18.1	26	18.3	33.6
Henry St, Tighes Hill	30/12/2012	35.8	14.8	21.9	19.4	25.9
	31/12/2012	67.3	17.9	29.8	17.1	39.6
	1/01/2013	50	25.2	45.6	34.5	35.4
	2/01/2013	59.6	19.2	33.3	28.1	31.3
	3/01/2013	43.4	13.8	23.3	19.6	26.6
	4/01/2013	55.6	18.8	26.2	23.3	42.3
	5/01/2013	51.7	18.1	26	18.3	33.6
Winders Rd, Lochinvar	30/12/2012	29.3	14.8	21.9	19.4	25.9
	31/12/2012	28.9	17.9	29.8	17.1	39.6
	1/01/2013	29.6	25.2	45.6	34.5	35.4
	2/01/2013	50.9	19.2	33.3	28.1	31.3
	3/01/2013	33.9	13.8	23.3	19.6	26.6
	4/01/2013	27.7	18.8	26.2	23.3	42.3

Location	Date	Osiris $PM_{2.5}$ (ugm^{-3})	EPA Wallsend $PM_{2.5}$ (ugm^{-3})	EPA Beresfield $PM_{2.5}$ (ugm^{-3})	Orica Stockton $PM_{2.5}$ (ugm^{-3})
Upfold St, Mayfield	10/12/2012	6.9	2.1	3.6	3.1
	11/12/2012	12.2	4.2	5.3	5.5
	12/12/2012	6.5	3.9	4.4	2.3
	13/12/2012	5	3.7	4.9	4.0
	14/12/2012	6.9	5	6.1	4.9
	15/12/2012	10.4	6.7	8.4	6.4
Crebert St, Mayfield	11/12/2012	20.8	4.2	5.3	5.5
	12/12/2012	7.8	3.9	4.4	2.3
	13/12/2012	8.3	3.7	4.9	4.0
	14/12/2012	10.5	5	6.1	4.9
	15/12/2012	15.1	6.7	8.4	6.4
Maitland Rd, Hexham	18/12/2012	9.7	9	8.8	5.0
	19/12/2012	8.9	8.7	8.7	7.7
	20/12/2012	11.4	11.3	11	14.8
Deschamps Cl, Thornton	18/12/2012	11	9	8.8	5.0
	19/12/2012	11.5	8.7	8.7	7.7
	20/12/2012	14.2	11.3	11	14.8
Charles St, East Maitland	19/12/2012	13.2	8.7	8.7	7.7
	20/12/2012	18.1	11.3	11	14.8

O'Mara St,	23/12/2012	7.4	5	5.1	7.7
Mayfield East	24/12/2012	12.8	8.2	7.9	12.9
	25/12/2012	14.9	5.3	5.2	8.8
	26/12/2012	12.1	4.7	7	6.3
	27/12/2012	8.4	4.6	5.5	5.8
	28/12/2012	12	7.2	10.5	10.5
Park Ave,	23/12/2012	9.3	5	5.1	7.7
Kotara	24/12/2012	12.4	8.2	7.9	12.9
	25/12/2012	16.2	5.3	5.2	8.8
	26/12/2012	12.8	4.7	7	6.3
	27/12/2012	9.1	4.6	5.5	5.8
	28/12/2012	14.9	7.2	10.5	10.5
Garrett St,	24/12/2012	24	8.2	7.9	12.9
Carrington	25/12/2012	32.2	5.3	5.2	8.8
	26/12/2012	21.2	4.7	7	6.3
	27/12/2012	14.4	4.6	5.5	5.8
	28/12/2012	21.9	7.2	10.5	10.5
Cumberland Rd,	30/12/2012	12	6.3	5.7	5.1
East Maitland	31/12/2012	10.2	7.8	6.7	6.1
	1/01/2013	14.1	11.8	13.2	12.0
	2/01/2013	20.7	10.5	12.8	12.0
	3/01/2013	11.1	4.1	6.8	4.0
	4/01/2013	9.9	7.5	11.2	9.0
	5/01/2013	8.5	7.4	10.1	7.0
Henry St,	30/12/2012	8	6.3	5.7	5.1
Tighes Hill	31/12/2012	11.7	7.8	6.7	6.1
	1/01/2013	11.5	11.8	13.2	11.9
	2/01/2013	15.1	10.5	12.8	11.7
	3/01/2013	8.6	4.1	6.8	4.4
	4/01/2013	10.6	7.5	11.2	8.7
	5/01/2013	9.6	7.4	10.1	7.1
Winders Rd,	30/12/2012	9	6.3	5.7	5.1
Lochinvar	31/12/2012	9.1	7.8	6.7	6.1
	1/01/2013	8.5	11.8	13.2	12.0
	2/01/2013	17.2	10.5	12.8	12.0
	3/01/2013	9.2	4.1	6.8	4.0
	4/01/2013	8.2	7.5	11.2	9.0