Department of Science, Information Technology, Innovation and the Arts

Western - Metropolitan Rail Systems Coal Dust Monitoring Program

Final report

Great state. Great opportunity.

Queensland Government

Prepared by

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Disclaimer

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Executive summary

In March 2013 the Department of Science, Information Technology, Innovation and the Arts (DSITIA) commenced an investigation into particle levels along the Western and Metropolitan Rail Systems used by trains hauling coal from mines in the Clarence-Moreton and Surat Basins in southern Queensland to the Port of Brisbane. The main objective of the investigation was to obtain information on ambient particle levels along the coal rail corridor and to evaluate the effectiveness of a coal wagon veneering trial which commenced at the New Acland mine north of Oakey in May 2013. Coal from the New Acland mine accounts for approximately 60 per cent of all coal transported to the Port of Brisbane on the Western and Metropolitan rail systems.

The timing of the coal dust monitoring program was dictated by the date of commencement of coal wagon load profiling and veneering program at the New Acland mine in May 2013. Reduced dust emissions due to frequent rainfall during the investigation period, particularly in the months prior to and during the pre-veneering monitoring period, will have reduced measured particle levels.

The investigation focused on acquiring data to assess both health and nuisance impacts in the community, together with determination of the contribution of coal particles to overall dust levels. The monitoring program collected information on:

- PM_{10} (particles less than 10 micrometres in diameter) and $PM_{2.5}$ (particles less than 2.5 micrometres in diameter) levels—to assess possible human health impacts
- deposited dust (dustfall)—to assess possible amenity degradation (dust nuisance) impacts and to determine the contribution of coal particles to overall dust levels
- real-time particle levels—to assess the changes in short-term particle levels associated with the passage of different train types on the Metropolitan rail system.

Monitoring was conducted at six locations along the Western and Metropolitan rail systems used to transport coal to the Port of Brisbane (Oakey, Willowburn (Toowoomba), Dinmore, Tennyson, Fairfield and Coorparoo) and one background location on a section of the Metropolitan rail system not used by coal trains (Chelmer).

This report summarises the monitoring results obtained by DSITIA over the four-month dust monitoring program between early March and early July 2013, and provides an assessment of the impact of coal wagon veneering on ambient particle levels along the rail corridor following the commencement of coal wagon load profiling and veneering at the New Acland Mine on 2 May 2013.

The monitoring results showed that ambient particle concentrations complied with ambient air quality objectives at all rail corridor monitoring sites during both the pre- and post-veneering monitoring periods.

Ambient PM_{10} and $PM_{2.5}$ concentrations did not exceed the Queensland Environmental Protection (Air) Policy 2008 (EPP Air) 24-hour average air quality objectives of 50 $\mu g/m^3$ and 25 $\mu g/m^3$ respectively on any day during the investigation period. The highest average $PM_{2.5}$ concentration measured during either the pre- or post-veneering periods was less than the EPP Air annual objective value of 8 $\mu g/m^3$.

A number of observations point to the major influence on PM_{10} and $PM_{2.5}$ concentrations at the rail corridor monitoring sites being regional urban particle emission sources rather than rail transport emissions. These include the close correspondence between PM_{10} and $PM_{2.5}$ levels measured at

Metropolitan line rail corridor sites and DSITIA ambient air monitoring network sites elsewhere in Brisbane; the highest 24-hour $PM_{2.5}$ concentration during the pre-veneering period being recorded at the Chelmer background monitoring site; the lack of any strong relationship between PM_{10} and $PM_{2.5}$ levels and the proportion of winds from the direction of the rail corridor; little difference between PM_{10} and $PM_{2.5}$ measurements recorded on days when no coal and few freight train services were running and the average concentrations over the monitoring period; and the results of statistical analyses which found that any impact from veneering was less than the day-to-day variability in PM_{10} and $PM_{2.5}$ concentrations.

Insoluble dust deposition rates did not exceed the trigger level for dust nuisance of 4 g/m^2/30days above background levels (or 130 mg/m^2/day averaged over a 30-day period) recommended by the New Zealand Ministry for the Environment at any of the rail corridor monitoring sites during both the pre- and post-veneering monitoring periods.

Microscopic examination showed that mineral dust (soil or rock dust) was the major component (50 to 90 per cent) of larger particles that settled from the air at each monitoring site during both the pre- and post-veneering monitoring periods. Coal dust was consistently detected in the deposited dust from all monitoring sites along the rail corridor used by coal trains, but was only detected at trace levels in one sample at the Chelmer background monitoring site located on a section of the Metropolitan rail system not used by coal trains. Coal particles typically accounted for about 10 per cent of the total surface area in the deposited dust samples, with the amount present in individual samples ranging from trace levels up to 20 per cent of the total surface coverage. At most locations another black-coloured particle, rubber dust, was found to make up on average about 10 per cent of the deposited dust surface coverage.

A general trend towards decreased dust deposition rates and lower levels of coal dust in the deposited dust samples was observed at most monitoring sites following the implementation of rail wagon veneering at the New Hope Mine. While this suggests that veneering has reduced the loss of coal particles during transit, monitoring over a period longer than one to two months is needed to demonstrate that this improvement is ongoing. Collection of deposited dust samples over a 12 month period at one rail corridor monitoring site within Brisbane as part of the second phase of the Western - Metropolitan Rail Systems Coal Dust Monitoring Program will monitor this.

During both the pre- and post-veneering monitoring periods, the passage of trains was found to result in little change in 10-minute average PM_{10} and $PM_{2.5}$ levels at the Tennyson, Fairfield and Coorparoo monitoring sites. There was also little difference seen between the particle level variations associated with the passage of different train types past the monitoring sites.

The Queensland Department of Health has concluded that, for people living along the rail corridor, the dust concentrations, resulting from all particle sources, measured during the investigation are unlikely to result in any additional adverse health effects.

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Glossary of terms

AMCP	University of Queensland Applied Materials Characterisation and Performance Laboratory
Ash	The mass of the insoluble portion of particles deposited in a deposit gauge which remains after heating the sample to a temperature of 850°C for 30 minutes. This is an indication of the mineral content of the sample.
AS/NZS	Australian Standard/New Zealand Standard
Combustible matter	The mass of the insoluble portion of particles deposited in a deposit gauge which is lost on heating the sample to a temperature of 850°C for 30 minutes. This is an indication of the amount of organic matter in the sample.
Deposited dust	Particles collected in a deposit gauge which passes through a 1 mm mesh sieve.
DSITIA	Department of Science, Information Technology, Innovation and the Arts
DEHP	Department of Environment and Heritage Protection
EPP Air	Queensland Environmental Protection (Air) Policy 2008
$g/m^2/30days$	Grams per square metre per 30 day period. A measure of the average mass of particles settling on a unit area over a 30 day period.
Insoluble solids	The mass of the insoluble portion of particles deposited in a deposit gauge.
km/h	Kilometres per hour
µg	Microgram (= one millionth of a gram)
$\mu g/m^3$	Micrograms per cubic metre. A measure of the mass of particles suspended in a unit volume of air.
µm	Micrometre (= one millionth of a metre)
mg	Milligram (= one thousandth of a gram)
$mg/m^2/day$	Milligrams per square metre per day. A measure of the average mass of particles settling on a unit area on a daily basis.
ml	Millilitre
m/s	Metres per second. A measure of the speed of the wind.
$PM_{2.5}$	Atmospheric suspended particles having an aerodynamic diameter of less than 2.5 µm.
PM_{10}	Atmospheric suspended particles having an aerodynamic diameter of less than 10 µm.
SEM/EDS	Scanning electron microscopy with energy dispersive X-ray spectroscopy.
SIMTARS	Queensland Government Safety In Mines Testing And Research Station
Soluble solids	The mass of the soluble portion of particles deposited in a deposit gauge.
Total solids	Total mass of particles deposited in a deposit gauge (the sum of insoluble and soluble solids fractions).
Wind rose	A diagram representing the frequency distribution of wind speed and direction on a polar co-ordinate map. Wind direction is the direction the wind is blowing from.

Introduction

Approximately 9 million tonnes of export coal is currently transported each year to the Port of Brisbane from coal mines in the Clarence-Moreton and Surat Basins in southern Queensland via the Western and Metropolitan rail systems. These railway networks are owned and managed by Queensland Rail, while the coal haulage (train) services are undertaken by Aurizon. The coal haulage route starts just east of Miles, travels through Dalby, Toowoomba, Ipswich and the western and southern suburbs of Brisbane through to the Port of Brisbane.

The amount of coal handled through the Port of Brisbane is relatively small in relation to other coal export ports in Queensland. In 2011-2012, 8.84 million tonnes of coal was exported from the Port of Brisbane, compared with 59.4 million tonnes from ports at Gladstone, 82.9 million tonnes from Hay Point and Dalrymple Bay ports south of Mackay and 13.6 million tonnes from Abbot Point north of Bowen[1]. The largest coal export port in Australia is at Newcastle in New South Wales. A total of 121.9 million tonnes was exported from the Port of Newcastle in 2011-2012[2].

The lower coal throughput at the Port of Brisbane is also reflected in fewer and smaller coal trains compared with other rail systems. In 2010-2011, there were 3453 coal train services to the Port of Brisbane with an average payload of 1925 tonnes. By comparison, there were 7970 coal train services to ports at Gladstone (average payload 7006 tonnes), 7409 coal train services to ports at Mackay (average payload 10 000 tonnes), and 3047 coal train services to Bowen (average payload 5054 tonnes) in the same period[3]. In 2011 there were approximately 50 coal train services per day, or around 18 000 over the year, to the Port of Newcastle, with an average payload of 6932 tonnes per train[4].

At present the coal is transported to the Port of Brisbane in uncovered rail wagons. There is a history of complaints from residents of Brisbane suburbs along the Metropolitan rail line to the Port of Brisbane concerning dust nuisance from the transport of coal. Twenty-three formal complaints citing dust impacts from coal trains have been received by the Department of Environment and Heritage Protection since 2012, with the majority of these complaints coming from residents of suburbs from Tennyson to Woolloongabba. In addition to these formal complaints, there has been considerable media reporting of alleged community impacts as a result of dust emissions from coal trains.

In response to this public concern about coal dust emissions from trains and a Queensland Government challenge to improve environmental outcomes for residents living along the rail corridor, coal companies New Hope Group, Peabody Energy and Yancoal Australia and supply chain service providers Aurizon, Queensland Rail and Queensland Bulk Handling have voluntarily undertaken action to understand the sources and impacts of coal dust through air quality monitoring programs, as well as working towards implementing specific dust mitigation activities such as load profiling and veneering. Load profiling involves re-shaping the loaded coal surface to create a low-profile, garden-bed shape to reduce the dust emissions during transport and to ensure

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[1] Department of Natural Resources and Mines, *Annual coal statistics 2011 – 2012 financial year*, available at http://mines.industry.qld.gov.au/assets/coal-stats-pdf/fyr_1112.pdf, accessed 22 July 2013.

[2] Newcastle Port Corporation, *Media release: Impressive annual trade results for Port of Newcastle*, available at http://www.newportcorp.com.au/client_images/1085797.pdf, 2 August 2012, accessed 22 July 2013.

[3] QR National, *Coal system factsheets*, available at http://www.aurizon.com.au/OurBusiness/Coal/Forms/AllItems.aspx, accessed 22 July 2013.

[4] Australian Rail Track Corporation, *2012-2021 Hunter Valley Corridor Capacity Strategy Consultation Document*, available at http://www.artc.com.au/library/2012-21%20Hunter%20Valley%20Corridor%20Capacity%20Strategy%20FINAL.pdf, June 2012, accessed 22 July 2013.

the best possible coverage of coal by veneering spray. Veneering involves spraying a biodegradable non-toxic binding agent onto the loaded coal surface at the time of loading. The veneering solution binds the top layer of the coal surface together forming a flexible layer that reduces coal dust lift-off during transit.

As part of this response, New Hope Coal implemented load profiling and veneering of rail wagons at the New Acland Mine north of Oakey (which accounts for approximately 60% of total coal movements to the Port of Brisbane) from May 2013. All remaining coal companies transporting coal to the Port of Brisbane have committed to veneering their coal wagons by the end of 2013[5].

In conjunction with the decision by New Hope Coal, the Queensland Resources Council (on behalf of the coal companies and supply chain service providers) commissioned the Science Delivery Division of the Department of Science, Information Technology, Innovation and the Arts (DSITIA) to undertake a coal dust monitoring program to evaluate the health and nuisance impact of coal dust from trains on communities adjacent to the Western and Metropolitan rail systems and to assess the impact of this and subsequent coal wagon dust mitigation measures on dust levels. This investigation comprised two broad components:

1) monitoring at six locations across the Western and Metropolitan rail system and one background location on the Metropolitan rail system not used for coal transport for two separate one-month sampling periods – one month prior to implementation of coal wagon veneering at New Hope Coal's New Acland Mine (accounting for around 60 per cent of total tonnage of coal transported on the rail systems) and one month following full implementation of veneering at the New Acland Mine – to assess the impact of this dust mitigation measure on dust levels adjacent to the rail corridor; and
2) continuous monitoring at one location on the Metropolitan rail system for a further 12 month period to assess seasonal changes in dust levels and to measure and report on the progress of ongoing measures to reduce coal dust emissions.

Monitoring commenced at the seven Western and Metropolitan rail system locations in the first week in March 2013. The timing of the monitoring investigation was determined by the start of the veneering program at the New Acland mine, which was initially planned to commence in April 2013. Due to unseasonal heavy and frequent rainfall in March, a decision was made to defer the commencement of coal wagon load profiling and veneering at the New Acland Mine to enable the collection of a second month of pre-veneering monitoring data.

Due to operational problems with the real-time particle monitoring equipment at the Tennyson, Fairfield and Coorparoo monitoring sites which resulted in significant loss of data on the short-term variability in particle concentrations in the pre-veneering monitoring period, monitoring at these three sites was extended for a second month following the commencement of coal wagon veneering at the New Hope Mine to ensure sufficient data was available to assess the impact of train movements on ambient particle levels. All the monitoring equipment at these sites, not just the real-time particle monitoring equipment, was in operation during the second month.

This report provides a summary of the dust monitoring results obtained by DSITIA between March and June 2013, which includes the two-month period prior to the commencement of coal wagon load profiling and veneering at the New Acland Mine on 2 May 2013 and the following two-month period when approximately 60 per cent of all wagons transporting coal to the Port of Brisbane were treated to minimise loss of coal particles during transit. This report also evaluates the impact of coal wagon veneering at the New Acland Mine on ambient particle levels along the rail corridor.

[5] Queensland Resources Council, *Western/metropolitan rail corridor dust monitoring update*, available at https://www.qrc.org.au/01_cms/details.asp?ID=3248, 23 April 2013, accessed 22 July 2013.

An assessment of the human health risk posed by the particle concentrations measured during the investigation period has been prepared separately by the Queensland Department of Health and is included in Appendix 2.

Airborne particles

Airborne particles can be generated by many different processes, particularly in an urban context where a wide range of domestic, commercial, industrial and transport activities take place. While the size of the particles will depend on the particular process, in general combustion processes involving the burning of fuel (e.g. motor vehicle engines, industrial boilers, solid fuel heaters) will produce smaller particles than mechanical processes such as earthworks, mining, construction activities, and wind erosion.

Particulate matter can have a variety of health and amenity degradation (dust nuisance) effects depending on the concentration, the size of particles and the exposure time. Studies have linked increases in hospital admissions to elevated particulate matter exposure. Both long (over years) and short term (hours or days) particle exposure has been linked to health problems. Health effects associated with exposure to elevated levels of particulate matter include coughing, sneezing, wheezing and increased breathlessness. Potential amenity degradation effects of elevated dust levels include short term reduction in visibility, build-up of particulate matter on homes and soiling of washing. In general, particulate matter with an aerodynamic diameter greater than 10 micrometres (µm) tends to be associated with amenity degradation impacts, while particulate matter less than 10 µm (PM_{10}) is associated with health impacts.

While both PM_{10} and $PM_{2.5}$ size fractions have associations with adverse health outcomes, the results of some studies conducted with $PM_{2.5}$ have indicated that this size fraction may be more important than total PM_{10} for explaining the health effects attributed to exposure to particles[6].

As health impacts primarily relate to the concentration of suspended particulate matter that is breathed in, air quality standards to protect human health are expressed as a concentration, i.e. the mass of particulate matter that is suspended per unit volume of air, usually measured in micrograms per cubic metre ($\mu g/m^3$). Most amenity degradation impacts relate to the amount of particulate matter settling out on surfaces, hence guidelines for protection of amenity are expressed as the rate of deposition of particulate matter per unit surface area, usually measured in grams of dust that accumulates per square metre (g/m^2) over a 1 month period.

The atmospheric lifetime of particulate matter, that is how long the particle is airborne, depends on the size of the particle. Coarse particulate matter tends to deposit quickly and in relatively close proximity to its point of emission, whilst fine particulate matter may remain suspended in the atmosphere for many days and travel many hundreds of kilometres. It should be noted that, whilst smaller particles have longer atmospheric lifetimes, they also disperse as they travel. Dispersion will quickly reduce the overall concentration of particles.

[6] National Environment Protection Council, *Impact Statement for $PM_{2.5}$ Variation: Setting a $PM_{2.5}$ Standard in Australia*, available at http://www.scew.gov.au/sites/www.scew.gov.au/files/resources/9947318f-af8c-0b24-d928-04e4d3a4b25c/files/aaq-pm25-impstat-impact-statement-pm25-variation-final-200210.pdf, October 2002, accessed 22 July 2013.

Particle emissions from rail transport

For rail transport in general, emissions of particles can be produced by wind erosion of loose soil and other material present in the rail corridor during the passage of trains (this may also occur in the absence of trains during strong winds) and engine emissions from diesel-powered locomotives.

In terms of the size of the particles associated with rail transport, particles produced by wind erosion would be expected to be predominantly larger than 2.5 µm in diameter, and often larger than 10 µm in diameter. Particles emitted from diesel locomotives would be expected to be predominantly less than 2.5 µm in diameter. In south-east Queensland particles less than 2.5 µm from railway operations only make up approximately 0.1 per cent of the total amount of $PM_{2.5}$ emitted to the air[7].

In relation to coal trains, particle emissions can also result from erosion of the coal surface of loaded wagons or residual coal in unloaded wagons during transit. In addition, coal leakage from the doors of wagons and coal deposited on sills, shear plates and bogies of wagons during loading can be deposited in the rail corridor, where it can be subsequently re-entrained into the air by wind erosion. The amount and rate of coal dust emitted from coal trains is variable and is dependent upon factors such as the surface area of coal exposed to air currents during transport, the shape or profile of load, the properties of the coal (dustiness, moisture content), the train type, speed, and vibration, the transport distance and route characteristics, and rainfall[8].

Coal dust particles associated with rail transport would be most likely to be present as larger dust particles that settle from the air, but some will exist as PM_{10} particles.

As discussed in the previous section, it should be noted that the wide range of different particle emission sources, especially in an urban environment, means that particle emissions from rail transport will only make up part of the overall ambient particle measurements recorded by air quality monitoring instruments.

Ambient particle standards and guidelines

Current air quality standards or guidelines do not contain specific criteria for levels of coal dust in ambient air. In this report, assessment of possible health and amenity degradation impacts associated with the particle levels measured during the pre- and post-veneering monitoring periods has been conducted by comparing the measured levels against recognised standards and guidelines developed for the total amount of particles of a particular size present in the air, regardless of source or composition. This means that the assessments presented in this report refer to particles present at the monitoring sites from all sources, not just coal trains.

[7] Environmental Protection Agency and Brisbane City Council, *Air Emissions Inventory South-east Queensland region*, available from http://www.ehp.qld.gov.au/air/pdf/reports/air-emissions-inventory-seq.pdf, April 2003, accessed 22 July 2013.

[8] Katestone Environmental, *Review of Dust from Coal Trains in Queensland*, in Queensland Resources Council, *Submission to the Federal Senate Standing Committee on Community Affairs Inquiry into the impacts on health of air quality in Australia*, available at http://www.aph.gov.au/Parliamentary_Business/Committees/Senate_Committees?url=clac_ctte/air_quality/submissions.htm, Appendix A, March 2013, accessed 22 July 2013.

There is an established national approach to setting air quality standards in Australia[9,10]. This process is established by the *National Environment Protection Council Act 1994 (Cth)* through National Environment Protection Measures (NEPMs). The aim of the Ambient Air Quality NEPM is ambient air quality that allows for the adequate protection of human health and well-being. The Queensland Environment Protection (Air) Policy 2008 (EPP Air) adopted the Ambient Air Quality NEPM standards as air quality objectives.

Ambient PM_{10} concentrations have been compared with the EPP Air 24-hour air quality objective of 50 µg/m^3. Ambient $PM_{2.5}$ concentrations have been compared with the EPP Air 24-hour and annual air quality objectives of 25 µg/m^3 and 8 µg/m^3 respectively.

No ambient PM_{10} or $PM_{2.5}$ guidelines for protection of human health have been developed for exposure periods shorter than 24 hours.

Regarding amenity degradation, there are currently no Australian ambient air quality guidelines for deposited dust. In the absence of an Australian objective, measured deposited dust levels were compared against the dust nuisance trigger level of 4 g/m^2/30 days above background concentrations, or 130 mg/m^2/day expressed on a daily basis, recommended by the New Zealand Ministry of the Environment[11]. The acceptable concentration of deposited dust is related to the sensitivity of the receiving environment. The New Zealand guideline document notes that in sensitive residential areas deposition rates lower than the recommended trigger level may cause nuisance.

Monitoring program design

The broad objectives of the initial monitoring component of the Western and Metropolitan Rail Systems Coal Dust Monitoring Program at sites across the rail systems were to:

- undertake dust monitoring at sites along the rail corridor which are representative of dust exposure levels at or near key population areas
- quantify the exposure to particles that pose a health risk and/or amenity degradation (dust nuisance) that the community experiences near the edge of the rail corridor
- quantify, to the extent possible given different seasonal sampling conditions, the impact of coal wagon dust mitigation measures on dust levels in the community
- quantify, to the extent possible, the short-term changes in particle levels associated with the passage of different train types on the Metropolitan rail system
- report on the air quality monitoring results and provide an assessment of likely amenity degradation (dust nuisance) impacts and health risks from current dust exposures.

To achieve these aims, the initial component of the study involving monitoring at seven locations on the Western and Metropolitan rail system collected information on:

- PM_{10} and $PM_{2.5}$ levels—to assess possible health impacts

[9] National Environment Protection Council, *National Environment Protection (Ambient Air Quality) Measure – Revised Impact Statement*, available from http://www.scew.gov.au/sites/www.scew.gov.au/files/resources/9947318f-af8c-0b24-d928-04e4d3a4b25c/files/aaq-impstat-aaq-nepm-revised-impact-statement-final-199806.pdf, 1998, accessed 22 July 2013.

[10] National Environment Protection Council, *Methodology for setting air quality standards in Australia Part A*, available at http://www.scew.gov.au/sites/www.scew.gov.au/files/resources/458719dc-73eb-4cfd-a688-a36b32e80f6c/files/methodology-air-quality-standards-australia-parta.pdf, 2011, accessed 22 July 2013.

[11] New Zealand Ministry for the Environment, *Good Practice Guide for Assessing and Managing the Environmental Effects of Dust Emissions*, available at http://www.mfe.govt.nz/publications/air/dust-guide-sep01.pdf, 2001, accessed 22 July 2013.

- deposited dust (dustfall)—to assess possible amenity degradation impacts and the contribution of coal particles to overall dust settling out on surfaces
- real-time particle levels—to assess the changes in short-term particle levels associated with the passage of different train types.

Monitoring locations

Monitoring was conducted at six locations along the Western – Metropolitan rail system used to transport coal to the Port of Brisbane (Oakey, Willowburn (Toowoomba), Dinmore, Tennyson, Fairfield and Coorparoo) and one background location on a section of the Metropolitan rail system that is not used by coal trains (Chelmer) – see Figure 1. As the study aimed to determine a 'worst case' situation to maximise any differences in particle levels between the pre- and post-veneering periods, the monitoring equipment was sited within the rail corridor rather than in the surrounding community. The monitoring locations were chosen based on both complaint history and, where practicable, compatibility with the sites used in a previous study of coal dust levels between West Ipswich and the Port of Brisbane[12]. The Tennyson, Fairfield and Coorparoo sites used in this study were in similar positions to the sites used in that 1999 investigation.

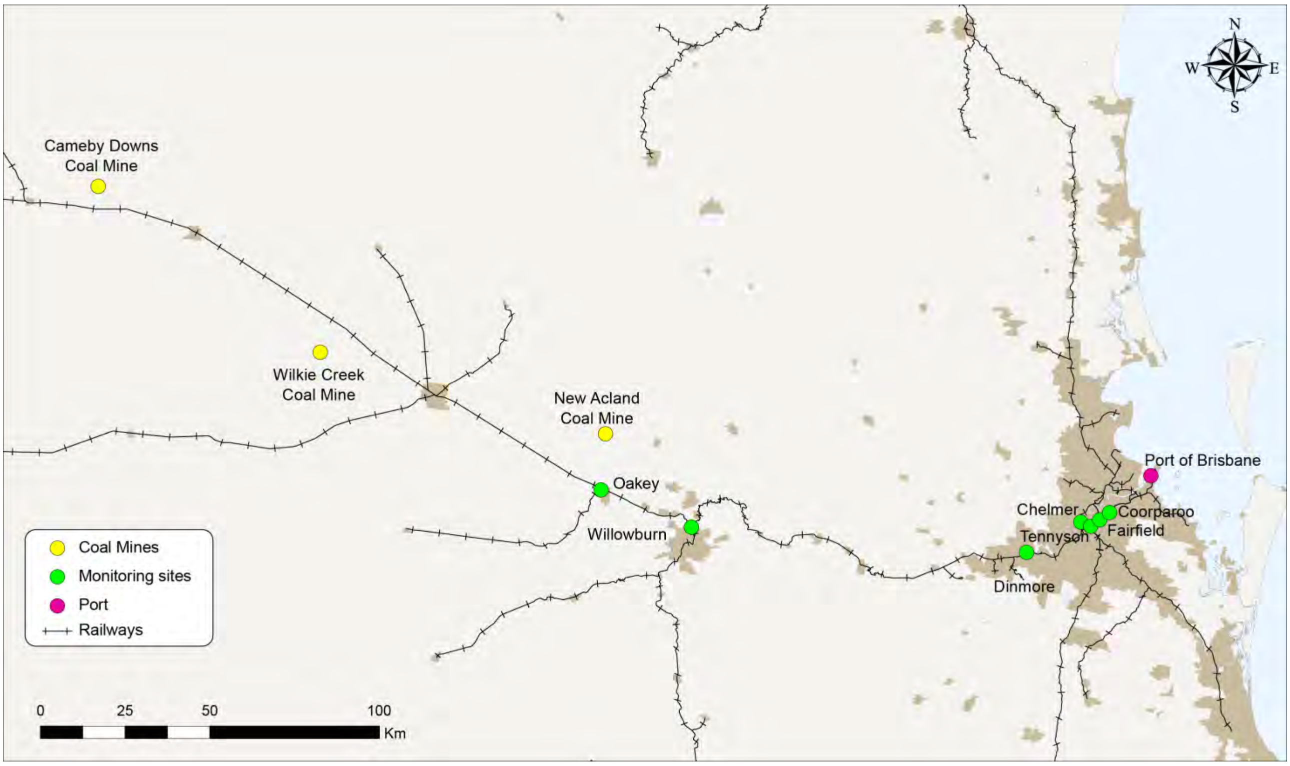

Figure 1: Map showing coal mine and rail corridor monitoring site locations on the Western – Metropolitan rail system.

In order to source power to operate the PM_{10}, $PM_{2.5}$ and real-time particle monitoring equipment and to gain access to the rail corridor, it was necessary to locate the monitoring equipment at railway stations where the necessary infrastructure was in place. While all attempts were made to site the monitoring equipment at similar distances from the rail line at each of the monitoring sites; factors such as the number of rail tracks, rail corridor access, power supply access and health and safety restrictions meant that consistency could not be achieved across the seven sites. Details of

[12] SIMTARS, *Coal Dust Monitoring: West Ipswich to Fisherman Islands – Queensland Rail Twelve Month Summary Report*, File Reference 50/003/50/1/16, 1999.

the individual monitoring sites and parameters measured are summarised in Table 1 and the equipment locations at each of the monitoring sites are shown in Figures 2 to 8.

Table 1: Details of Western and Metropolitan rail systems rail corridor monitoring locations.

Monitoring site	Number of rail tracks	Maximum train speed		Position relative to rail line	Distance from nearest rail track	Distance from furthest rail track	Measurement parameters
		Freight	Passenger				
Oakey	2	25 km/h (both directions)	25 km/h (both directions)	North	10 metres	14 metres	PM_{10}, $PM_{2.5}$ Deposited dust Wind speed and direction
				South	6 metres	9 metres	Deposited dust
Willowburn (Toowoomba)	1	60 km/h (both directions)	60 km/h (both directions)	East	8 metres	-	Deposited dust
				West	8 metres	-	Deposited dust
Dinmore	2	80 km/h (both directions)	80 km/h (both directions)	North	9 metres	13 metres	Deposited dust
				South	21 metres	24 metres	PM_{10}, $PM_{2.5}$ Deposited dust Wind speed and direction
Tennyson	2	50 km/h (both directions)	50 km/h (both directions)	North	7 metres	11 metres	Real-time particles Deposited dust Wind speed and direction
				South	5 metres	9 metres	Deposited dust
Fairfield	3	80 km/h (both directions)	70 km/h (to City) 80 km/h (from City)[a]	East	8 metres	22 metres	PM_{10}, $PM_{2.5}$ Real-time particles Deposited dust Wind speed and direction
				West	2 metres	15 metres	Deposited dust
Coorparoo	3	80 km/h (both directions)	60 km/h (to City) 80 km/h (from City)[a]	North	5 metres	26 metres	PM_{10}, $PM_{2.5}$ Real-time particles Deposited dust Wind speed and direction
				South	3 metres	23 metres	Deposited dust
Chelmer (background)	4	70 km/h (to City platform 1) 90 km/h (to City platform 3) 80 km/h (from City)	70 km/h (to City platform 1) 90 km/h (to City platform 3) 80 km/h (from City)	East	7 metres	24 metres	PM_{10}, $PM_{2.5}$ Deposited dust Wind speed and direction

[a] express trains are permitted to travel at 100 km/h

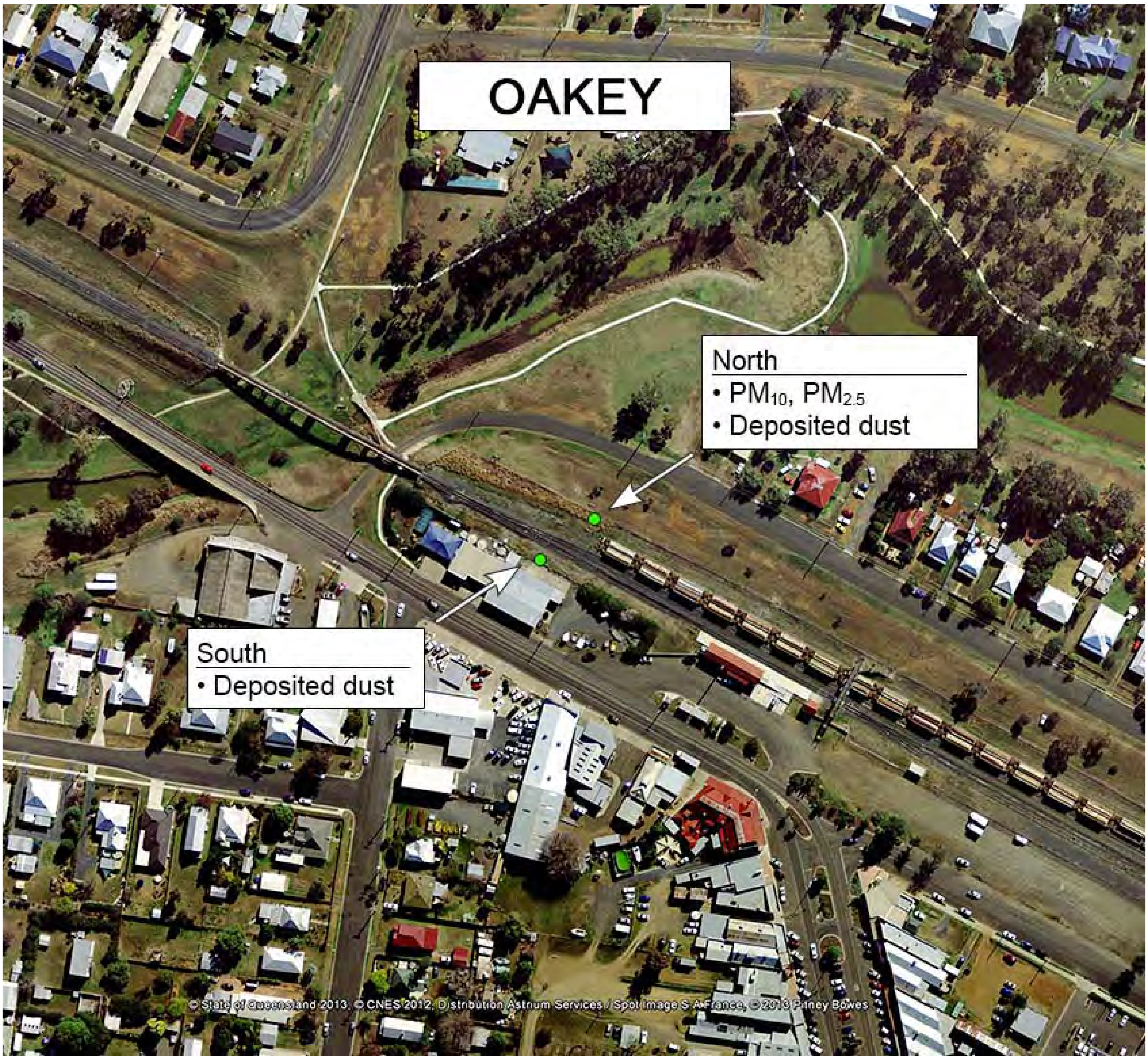

Figure 2: Monitoring equipment locations at the Oakey monitoring site.

At Oakey the monitoring equipment was located at the Oakey Railway Station. In addition to rail transport, other airborne particles sources in the vicinity of the monitoring site included emissions from vehicles using nearby roads, abattoir boiler emissions, domestic solid fuel heaters and windblown dust from exposed ground.

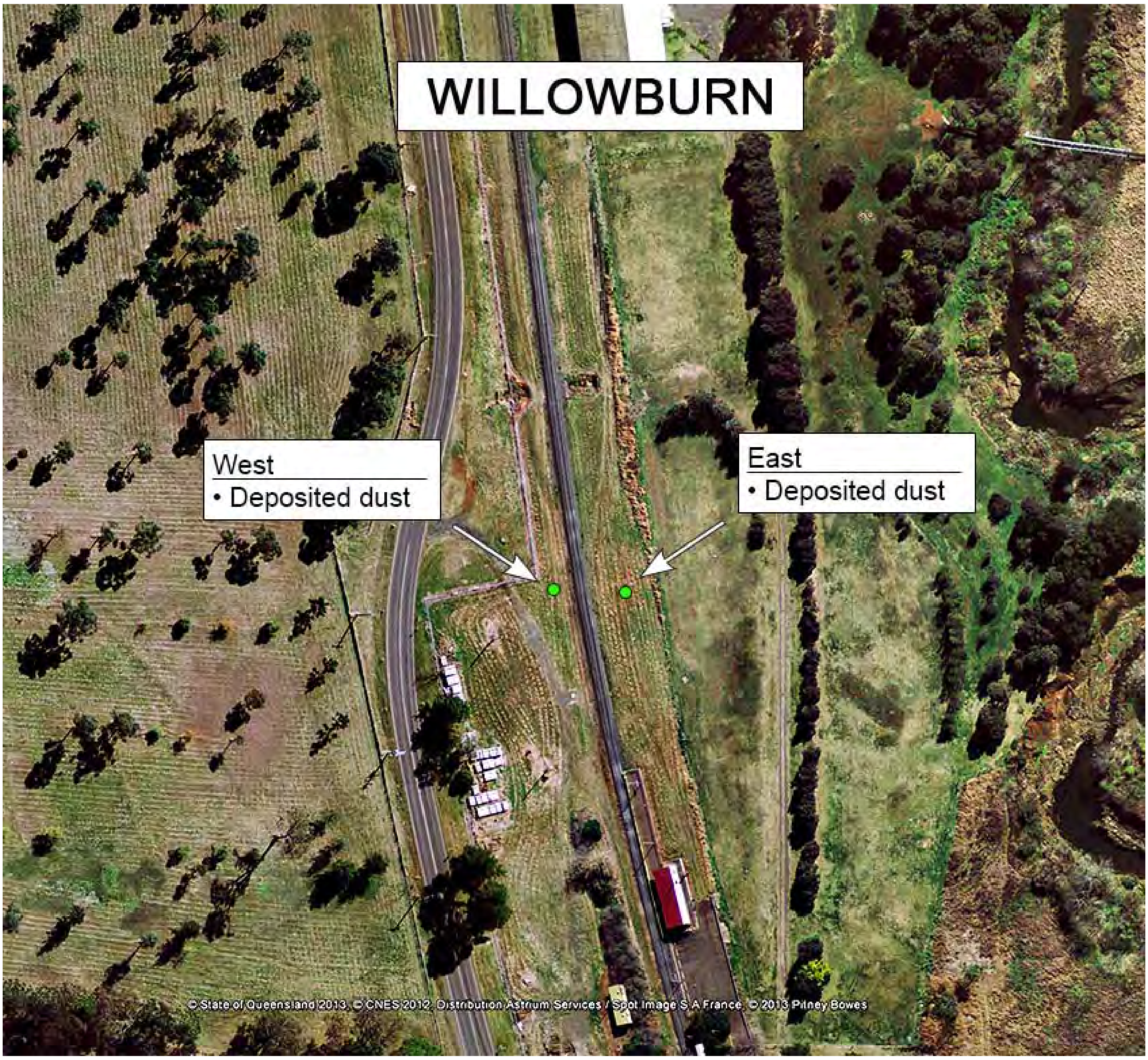

Figure 3: Monitoring equipment locations at the Willowburn (Toowoomba) monitoring site.

At Willowburn the monitoring equipment was located at the disused Willowburn Railway Station. In addition to rail transport, other particle sources in the vicinity of the monitoring site that could contribute to the deposited dust collected included windblown dust from exposed ground or re-entrainment by vehicles using nearby roads and nearby landscaping businesses.

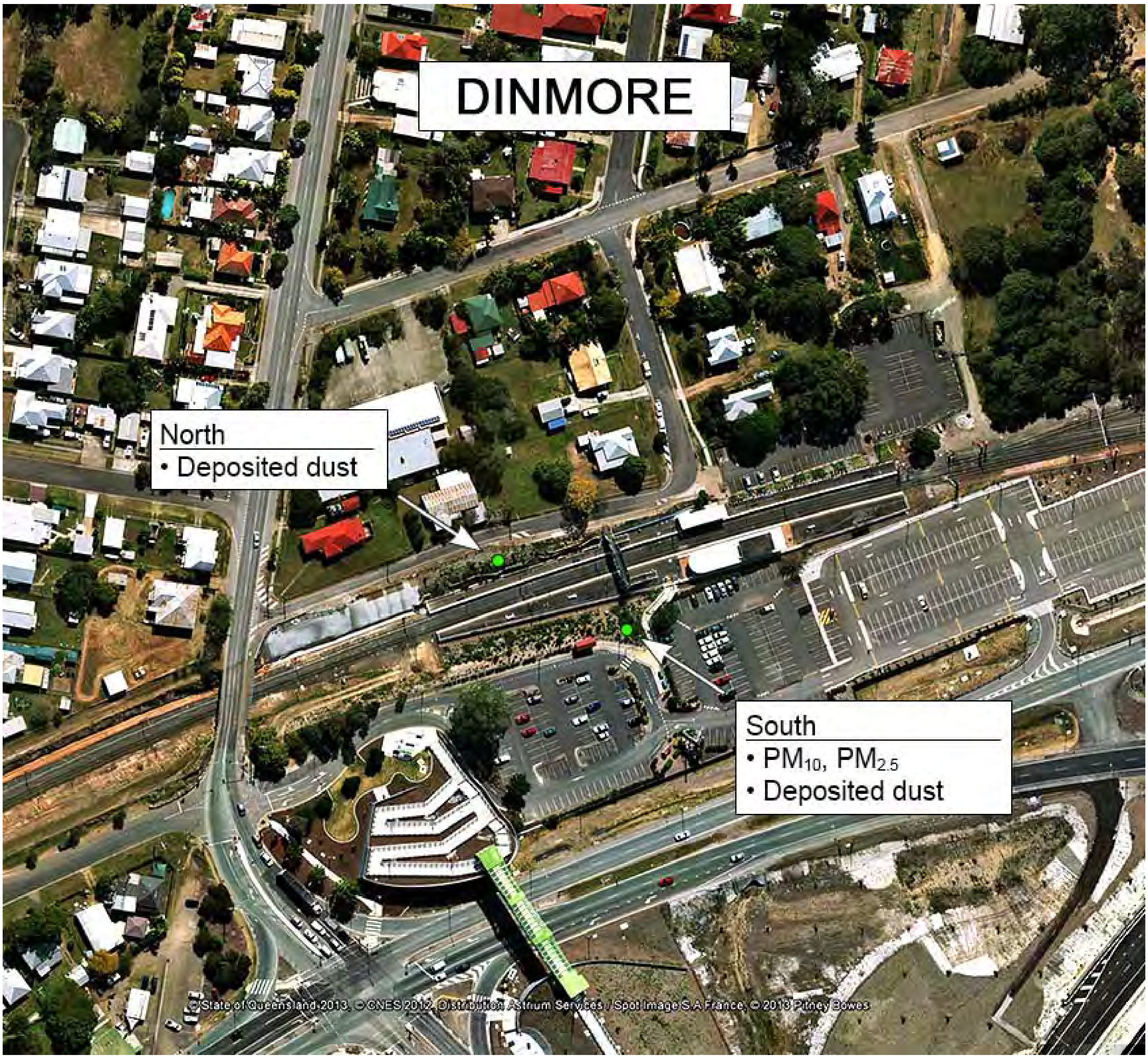

Figure 4: Monitoring equipment locations at the Dinmore monitoring site.

At Dinmore the monitoring equipment was located at the Dinmore Railway Station. The Dinmore Railway Station is situated close to a number of major road traffic corridors, including Brisbane Road and the Cunningham Highway within 300 m to the south and the Warrego Highway approximately 600 m to the north. These roads carry around 50 000 vehicles per day, with about 10 per cent being commercial (heavy) vehicles. Emissions from these vehicles will have contributed to particle levels measured at the monitoring site.

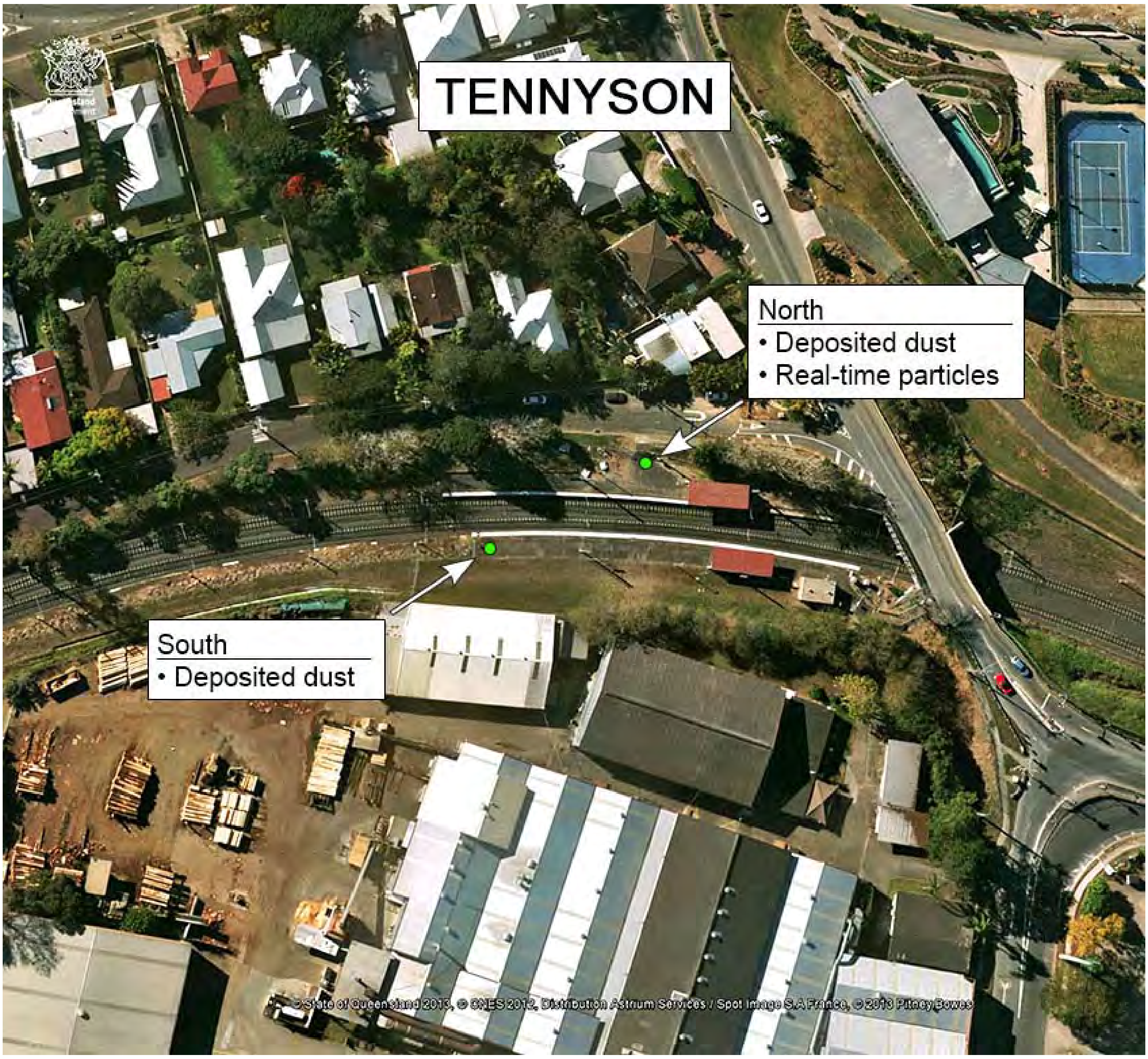

Figure 5: Monitoring equipment locations at the Tennyson monitoring site.

At Tennyson the monitoring equipment was located at the disused Tennyson Railway Station. In addition to rail transport, other airborne particles sources in the vicinity of the monitoring site included emissions from vehicles using nearby roads including Fairfield Road 700 m to the east with a daily traffic volume of approximately 40 000 vehicles, freight yard and plywood manufacturing.

Figure 6: Monitoring equipment locations at the Fairfield monitoring site.

At Fairfield the monitoring equipment was located at the Fairfield Railway Station. The Fairfield monitoring site was situated between two major road traffic corridors – Fairfield Road 300 m to the west carrying approximately 40 000 vehicles per day and Ipswich Road 400 m to the east carrying approximately 80 000 vehicles per day. Emissions from these vehicles will have contributed to particle levels measured at the monitoring site. At the Fairfield site loaded coal trains used a separate rail line dedicated for freight services. The Fairfield (West) deposited dust sampler was situated adjacent to this freight rail line.

Figure 7: Monitoring equipment locations at the Coorparoo monitoring site.

At Coorparoo the monitoring equipment was located at the Coorparoo Railway Station. In close proximity to the Coorparoo monitoring site were three major road traffic corridors –Stanley Street East 300 m to the north (carrying approximately 20 000 vehicles per day), Cavendish Road less than 100 m to the east (carrying approximately 12 000 vehicles per day) and Old Cleveland Road 600 m to the south (approximately 30 000 vehicles per day). Emissions from these vehicles will have contributed to particle levels measured at the monitoring site. At the Coorparoo site loaded coal trains used a separate rail line dedicated for freight services. The monitoring equipment at Coorparoo (North) was situated adjacent to this freight rail line.

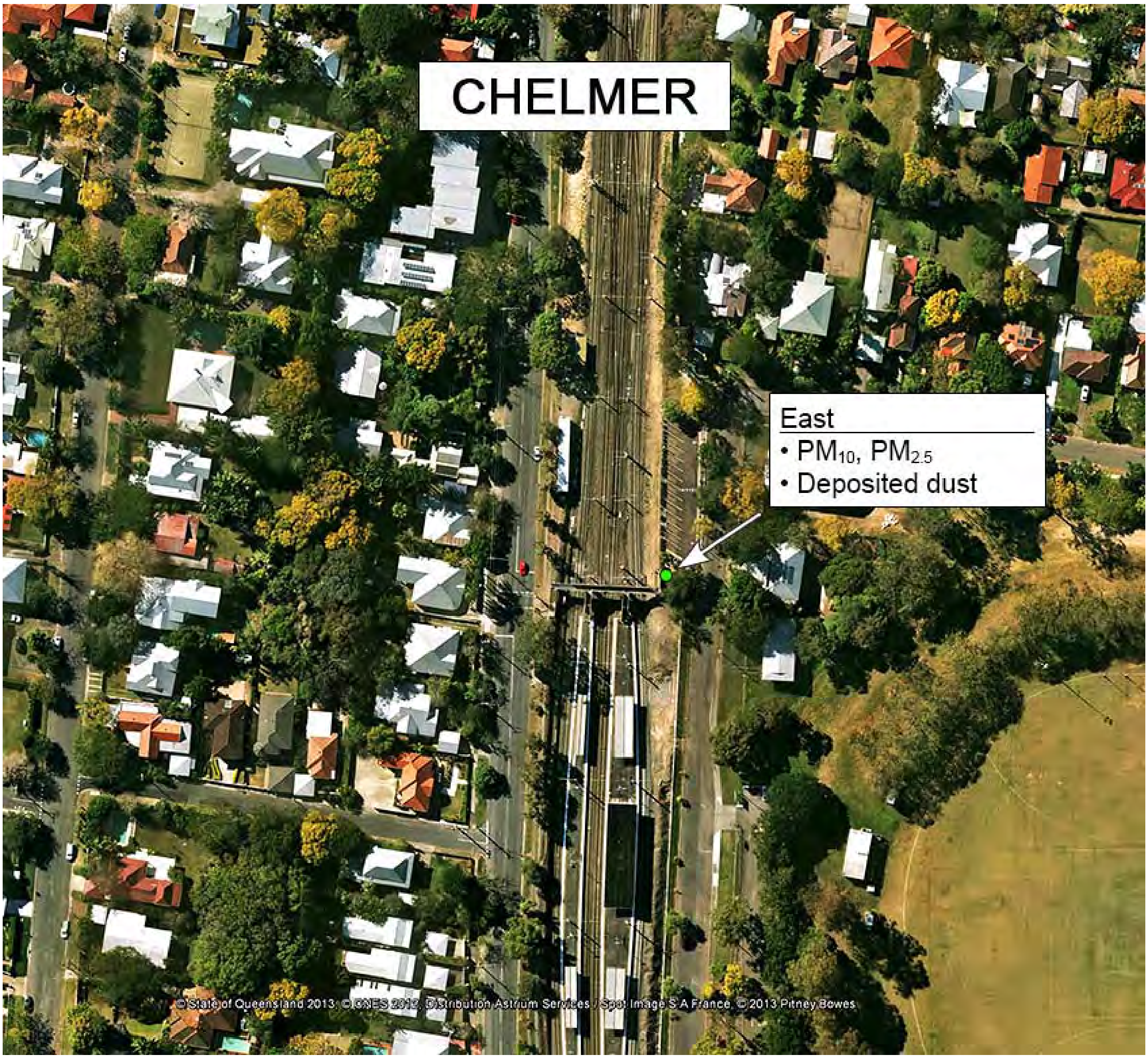

Figure 8: Monitoring equipment locations at the Chelmer background monitoring site.

The Chelmer Railway Station was chosen as the location for the background monitoring station. The purpose of this site was to provide an indication of particle levels within the rail corridor in the absence of coal trains. The Chelmer Railway Station site was over three kilometres from the nearest section of the Metropolitan rail corridor used by coal trains. Local particle sources in the vicinity of the monitoring site were emissions from vehicles travelling on Honour Avenue along the western side of the rail corridor (approximately 3000 vehicles per day) and Oxley Road 250 m to the east (approximately 16 000 vehicles per day).

Monitoring equipment

Daily 24-hour average PM_{10} and $PM_{2.5}$ samples were collected at the Oakey, Dinmore, Fairfield, Coorparoo and Chelmer monitoring sites using Partisol® Model 2025 or dichotomous Partisol® Model 2025-D sequential low-volume air samplers. These samplers were capable of changing sample filters automatically every 24 hours, allowing unattended operation for up to 16 days. The samplers were operated in accordance with Australian/New Zealand Standard AS/NZS 3580.9.9:2006 Method 9.9: Determination of suspended particulate matter – PM_{10} low-volume sampler – Gravimetric method or Australian/New Zealand Standard AS/NZS 3580.9.10:2006 Method 9.10: Determination of suspended particulate matter – $PM_{2.5}$ low-volume sampler – Gravimetric method.

The Model 2025 sequential air samplers operated by drawing air through a PM_{10} size-selective inlet (to remove particles larger than 10 µm) or a $PM_{2.5}$ size-selective inlet (to remove particles larger than 2.5 µm) and depositing the particles on a pre-weighed 47mm diameter Teflon® filter over a 24-hour period from midnight to midnight. After sampling, the filter was again weighed, with the difference in weight being the mass of PM_{10} or $PM_{2.5}$ particles collected. The PM_{10} or $PM_{2.5}$ mass concentration was calculated by dividing the mass of PM_{10} or $PM_{2.5}$ particles collected by the volume of air drawn through the sampler over the 24-hour sampling period.

The dichotomous Model 2025-D samplers operated by firstly drawing air through a PM_{10} size-selective inlet, then through a virtual impactor to separate the incoming PM_{10} air stream into its fine (particles less than 2.5 µm in diameter, $PM_{2.5}$) and coarse (particles between 2.5 µm and 10 µm in diameter, $PM_{10-2.5}$) components which were deposited on separate pre-weighed 47mm Teflon® filters over a 24-hour period from midnight to midnight. After sampling, the filters were again weighed, with the difference in weight being the mass of $PM_{2.5}$ and $PM_{10-2.5}$ particles collected. The $PM_{2.5}$ mass concentration was calculated by dividing the mass of $PM_{2.5}$ particles collected by the volume of air drawn through $PM_{2.5}$ stream of the sampler over the 24-hour sampling period. The PM_{10} mass concentration was calculated by dividing the sum of the masses of $PM_{2.5}$ and $PM_{10-2.5}$ particles collected by the sum of the volume of air drawn through the $PM_{2.5}$ and $PM_{10-2.5}$ streams over the 24-hour sampling period.

PM_{10} and $PM_{2.5}$ sample collection was carried out by DSITIA field staff and the gravimetric analysis was carried out by the Queensland Government Safety in Mines, Testing and Research Station (SIMTARS).

Deposited dust was monitored at all monitoring sites by determining the amount of dust collected over an exposed surface in a fixed period of time. Measurement was by means of a funnel and collection bottle, which simply caught the dust settling over a fixed surface area over a period of approximately 30 days. Collection bottles were placed on opposite sides of the rail line at each monitoring site, to account for different wind directions experienced during the monthly sampling period.

Collection of deposited dust samples was carried out in accordance with Australian/New Zealand Standard AS/NZS 3580.10.1:2003 Method 10.1 Determination of particulates – Deposited Matter – Gravimetric method. Prior to analysis, the solution contained in the collection bottle was homogenised and a 100 ml sub-sample was extracted for the coal dust identification analysis. Sample analysis was performed using a modification to the method specified in AS/NZS 3580. Instead of filtering all of the collected solution (less the coal dust identification sub-sample), a homogenised extract of between 250 ml and 500 ml was analysed and the results were multiplied up to reflect the total volume of solution originally present in the collection bottle. Internal testing and analysis of duplicate samples by an external laboratory showed that there was no significant difference in the results obtained between the standard method and this variation to the standard method. The results were reported in terms of the weight of dust collected per unit of surface area over the sampling period. Sample collection was carried out by DSITIA field staff and the analysis was carried out by DSITIA's Chemistry Centre laboratory.

Determination of coal particle content was performed by microscope examination of the sub-sample extracted from the deposited dust samples before the deposited dust analysis was carried out. The deposited dust sub-sample solution was filtered onto a membrane filter and examined by stereomicroscopy for particle distribution (surface coverage) and general appearance. This was followed by the use of scanning electron microscopy with energy dispersive X-ray spectroscopy (SEM/EDS) of selected individual particles to confirm that the particles assessed by stereomicroscopy as coal particles were actually coal particles. The coal dust identification work was performed by the Applied Materials Characterisation and Performance Laboratory (AMCP) at the University of Queensland. AMCP are considered nationally as experts in coal dust determination and the techniques used in this investigation have been previously applied to other coal dust studies in Queensland.

At the Tennyson, Fairfield and Coorparoo monitoring sites, continuous 5-minute averaged particle measurements were also collected using a Model 8533 Dusttrak™ DRX Aerosol Monitor to determine the magnitude of short-term increases in particle levels associated with the passage of different types of trains using the Metropolitan rail system. The Dusttrak™ analysers drew air into a sensing chamber where the air stream was illuminated by light from a laser diode. Particles present in the air stream caused the light beam to be scattered, with the amount of scattering being measured by a photodetector mounted at 90^{o} to the air stream. The aerosol concentration was determined by the overall photodetector response, while individual pulses from the photodetector provided a measure of the size of the particle causing the light scattering. The Dusttrak™ instrument was chosen due to its fast response time to particle concentration changes. However, as the Dusttrak™ instrument does not directly measure particle mass, the recorded particle concentrations could not be used to determine compliance with air quality guidelines expressed in gravimetric (i.e. mass per volume) units. Comparison of the 24-hour average $PM_{2.5}$ and PM_{10} concentrations reported by the Dusttrak™ instrument with the corresponding measurements from the Partisol® instruments at the Fairfield and Coorparoo monitoring sites provided approximate adjustment factors. These factors have been applied to Dusttrak™ data presented in this report.

Wind speed and direction measurements averaged over 30-minute periods were recorded at all monitoring sites, except Willowburn, to assist with analysis of the contribution of different particle sources to overall particle levels. As only monthly deposited dust sampling was conducted at the Willowburn site, it was decided that the wind data from the Oakey monitoring site would be sufficient for dust impact analysis purposes.

At those monitoring sites measuring PM_{10} and $PM_{2.5}$, a Gill Windsonic ultrasonic wind sensor was connected to the inbuilt wind sensor input on the Partisol® sequential low-volume air sampler, which recorded 30-minute averaged wind speed and direction measurements. At the Tennyson monitoring site, a Vaisala WXT-520 ultrasonic wind sensor connected to a stand-alone datalogger was used to collect wind speed and direction data. The wind sensors operated by measuring the speed at which sound waves travelled through the air between two sets of transducers. The wind sensors were located at a height of approximately six metres above ground level.

Results and discussion

Train movements

Train movement data for the dust monitoring site locations during the pre- and post-veneering monitoring periods was supplied by Queensland Rail and is summarised in Tables 2 and 3 respectively. Daily train movements were essentially unchanged between the pre- and post-veneering monitoring periods.

On average, 12 loaded and 12 unloaded coal trains passed the Oakey and Willowburn monitoring sites each day. At sites on the Metropolitan rail line an average of 13 to 14 loaded and unloaded coal trains travelled past the rail corridor monitoring sites each day. The maximum number of loaded and unloaded coal train movements on any one day was 19 and 18 respectively. Other rail freight services were less frequent, with highest levels being at the Tennyson and Fairfield monitoring sites where there were 10 and 11 services per day on average. Monitoring sites on the Metropolitan rail line (with the exception of Tennyson) experienced high passenger train service numbers, almost all of which were electric trains.

During the investigation period, all coal trains using the Western – Metropolitan rail systems were hauled by two diesel locomotives located at the front of the train and had a consistent number of coal wagons (as demonstrated by the fact that 99 per cent of all unloaded coal trains had a gross

Table 2: Summary of train movement data at the rail corridor monitoring sites during the pre-veneering monitoring period, March to April 2013.

Train type	Statistic[a]	Train movements at monitoring site						
		Oakey	Willowburn	Dinmore	Tennyson	Fairfield	Coorparoo	Chelmer
Coal (loaded)	Total	671	671	753	753	753	753	0
	Daily average	12	12	13	13	13	13	0
	Daily range	0 to 15	0 to 15	0 to 19	0 to 19	0 to 19	0 to 19	0
Coal (empty)	Total	675	675	756	755	755	756	1
	Daily average	12	12	13	13	13	13	0
	Daily range	0 to 15	0 to 15	0 to 18	0 to 18	0 to 18	0 to 18	0 to 1
Other freight	Total	64	64	184	577	625	269	336
	Daily average	1	1	3	10	11	5	6
	Daily range	0 to 5	0 to 5	0 to 6	1 to 16	1 to 17	0 to 8	0 to 12
Passenger	Total	34	34	5554	878	10821	5735	11439
	Daily average	1	1	96	15	187	99	197
	Daily range	0 to 2	0 to 2	0 to 128	0 to 79	130 to 240	64 to 116	0 to 257
Other	Total	37	39	45	229	332	125	81
	Daily average	1	1	1	4	6	2	1
	Daily range	0 to 4	0 to 5	0 to 4	0 to 10	2 to 13	0 to 9	0 to 6

[a] Information provided for each train type and monitoring site includes the total number of trains passing the monitoring site during the entire pre-veneering monitoring period (total); the average number of trains passing the monitoring site each day over the pre-veneering monitoring period (daily average); and the minimum and maximum number of trains passing the monitoring site on individual days during the pre-veneering monitoring period (daily range).

Table 3: Summary of train movement data at the rail corridor monitoring sites during the post-veneering monitoring period, May to June 2013.

Train type	Statistic[a]	Monitoring site						
		Oakey	Willowburn	Dinmore	Tennyson	Fairfield	Coorparoo	Chelmer
Coal (loaded)	Total	415	415	473	877	876	876	0
	Daily average	12	12	14	14	14	14	0
	Daily range	1 to 15	1 to 15	2 to 17	0 to 17	0 to 18	0 to 18	0
Coal (empty)	Total	416	416	481	884	884	884	0
	Daily average	12	12	14	14	14	14	0
	Daily range	1 to 15	1 to 15	2 to 17	0 to 18	0 to 18	0 to 18	0
Other freight	Total	21	21	128	640	655	295	277
	Daily average	1	1	4	10	11	5	8
	Daily range	0 to 2	0 to 2	0 to 6	0 to 17	2 to 17	0 to 8	0 to 19
Passenger	Total	24	24	3673	618	10821	5938	6894
	Daily average	1	1	108	10	175	96	203
	Daily range	0 to 2	0 to 2	72 to 127	0 to 18	0 to 207	0 to 116	0 to 251
Other	Total	10	13	17	237	324	127	40
	Daily average	0	0	1	4	5	2	1
	Daily range	0 to 4	0 to 5	0 to 4	0 to 9	0 to 11	0 to 6	0 to 5

[a] Information provided for each train type and monitoring site includes the total number of trains passing the monitoring site during the entire post-veneering monitoring period (total); the average number of trains passing the monitoring site each day over the post-veneering monitoring period (daily average); and the minimum and maximum number of trains passing the monitoring site on individual days during the post-veneering monitoring period (daily range).

mass between 810 and 820 tonnes, understood to be 41 wagons). The maximum permitted speed for freight trains at individual rail corridor monitoring sites ranged from 25 km/h to 80 km/h (see Table 1). Aurizon has advised that the maximum speeds of loaded and unloaded coal trains are 60 km/h and 80 km/h respectively across the entire Western and Metropolitan Rail Systems. Unloaded coal trains leaving the Port of Brisbane are guided by Queensland Rail network controllers and generally do not exceed speeds of 60 km/h in the metropolitan area. Data on the actual speed of individual trains as they passed the monitoring sites was not available.

Meteorology

An important factor influencing the outcome of this investigation was dust suppression due to heavy and persistent rainfall. This dust suppression would include a reduction in both the loss of coal particles from rail wagons during transport and less surface dust present on the rail corridor being re-entrained during the passage of trains. Table 4 compares the monthly rainfall totals measured between March and June 2013 at selected Bureau of Meteorology stations in South East Queensland encompassing the area covered by the rail corridor monitoring sites with long-term average totals[13]. This data shows that rainfall experienced during the pre-veneering study period in 2013 was significantly higher, and in most cases more frequent, than the long-term

[13] Bureau of Meteorology, *Climate Data Online*, available at http://www.bom.gov.au/climate/data/, accessed 29 August 2013.

values at all stations, particularly during March. These wet conditions will have resulted in considerable dust suppression, with the result that ambient particle measurements obtained during the investigation period were likely to under-represent levels that might be expected to occur during dry conditions.

Table 4: Comparison of Bureau of Meteorology monthly rainfall at selected South East Queensland locations during March and April 2013 with 30-year average values.

Bureau of Meteorology station	Monthly rainfall (mm)		Days with rainfall >1mm	
	2013	1981-2010 median[a]	2013	1981-2010 average[a]
March				
Oakey Airport	107.8	30.7	6	3.8
Toowoomba Airport	113.0	44.2	11	6.9
Amberley Airport	96.6	61.3	7	6.7
Archerfield Airport	159.2	85.9	13	7.6
Brisbane Airport	180.6	123.2	10	9.6
April				
Oakey Airport	29.0	21.0	4	3.5
Toowoomba Airport	41.0	31.8	3	4.1
Amberley Airport	88.6	33.2	5	5.3
Archerfield Airport	93.4	45.1	7	7.2
Brisbane Airport	152.4	77.4	13	8.3
May				
Oakey Airport	28.0	27.3	3	3.4
Toowoomba Airport	51.4	28.6	7	4.9
Amberley Airport	38.0	35.0	9	5.9
Archerfield Airport	28.6	60.6	7	7.3
Brisbane Airport	77.8	85.6	10	8.9
June				
Oakey Airport	34.2	17.4	6	2.9
Toowoomba Airport	61.2	31.0	8	4.7
Amberley Airport	68.0	27.0	6	4.0
Archerfield Airport	63.8	47.0	9	5.0
Brisbane Airport	80.0	37.4	8	5.2

[a] Toowoomba Airport data is only available from 1996. Long-term average values shown for the Toowoomba Airport site are for the period 1996 to 2013.

Wind direction was another important factor in the measurement of dust impacts at the monitoring sites. The wind direction ranges necessary for dust generated by the passage of coal trains to impact the monitoring sites, together with the proportion of winds within these ranges over the pre-veneering study period, are summarised in Table 5. Table 5 also details the average and maximum wind speeds experienced at each monitoring site during the pre-veneering and post-veneering monitoring periods. The distribution of winds over the pre-veneering and post-veneering monitoring periods for each site where wind measurements were collected is also shown in the wind roses in Figures 9 and 10. Overall, there was a higher proportion of winds blowing from the south to west quadrant during the post-veneering monitoring period compared to the pre-veneering monitoring period at all sites.

Table 5: Wind conditions at the rail corridor monitoring sites during the pre-veneering and post-veneering monitoring periods.

Monitoring site	Position relative to rail line	Wind range for dust impacts (deg)	Veneering period	Proportion of winds within dust impact range (%)			Average wind speed (m/s)	Maximum wind speed (m/s)
				Entire period	Deposited dust range	PM_{10}, $PM_{2.5}$ daily range		
Oakey	North	>120 to <300	Pre	23	18 to 28	0 to 90	1.4	3.9
			Post	34	34	0 to 92	1.6	5.1
	South	>300 to <120	Pre	77	72 to 82	not applicable	1.9	5.5
			Post	66	66	not applicable	1.7	4.9
Willowburn[a] (Toowoomba)	East	>170 to <350	Pre	17	14 to 19	not applicable	1.6	3.9
			Post	32	32	not applicable	1.7	5.1
	West	>350 to <170	Pre	83	81 to 86	not applicable	1.8	5.5
			Post	68	68	not applicable	1.7	4.9
Dinmore	North	>70 to <250	Pre	61	58 to 66	not applicable	1.7	6.8
			Post	91	90	not applicable	1.1	3.4
	South	>260 to <70	Pre	35	32 to 36	0 to 85	1.0	4.6
			Post	6	6	0 to 31	0.5	1.8
Tennyson	North	>100 to <270	Pre	77	76 to 79	5 to 100	0.9	7.6
			Post	89	88 to 89	50 to 100	1.0	5.0
	South	>260 to <95	Pre	23	21 to 23	not applicable	0.4	1.2
			Post	13	13 to 14	not applicable	0.4	2.1
Fairfield	East	>210 to <15	Pre	41	32 to 50	0 to 85	0.7	2.7
			Post	81	55 to 68	25 to 98	1.1	3.8
	West	>15 to <210	Pre	60	50 to 68	not applicable	0.9	2.8
			Post	20	33 to 46	not applicable	0.6	2.9
Coorparoo	North	>25 to <210	Pre	58	51 to 65	13 to 100	2.1	8.3
			Post	31	25 to 35	2 to 94	1.0	4.0
	South	>220 to <30	Pre	28	27 to 30	not applicable	0.9	4.2
			Post	44	44	not applicable	1.0	4.1
Chelmer (background)	East	>180 to <360	Pre	47	45 to 48	0 to 93	0.5	2.9
			Post	76	77	25 to 100	0.6	3.0

[a] Wind measurements from the Oakey site have been used to derive the summary wind information for the Willowburn site.

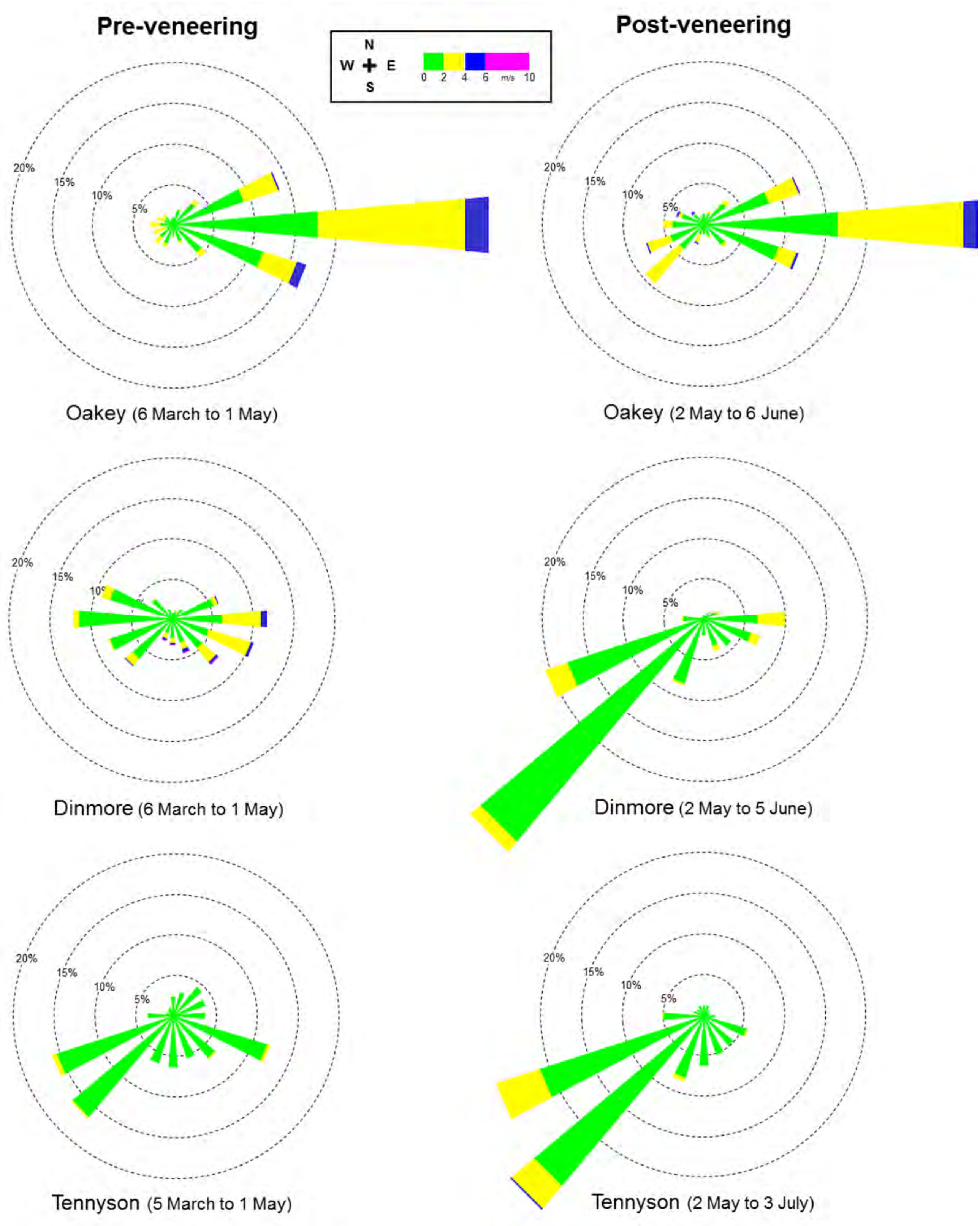

Figure 9: Wind roses at the Oakey, Dinmore and Tennyson monitoring sites during the pre-veneering and post-veneering monitoring periods

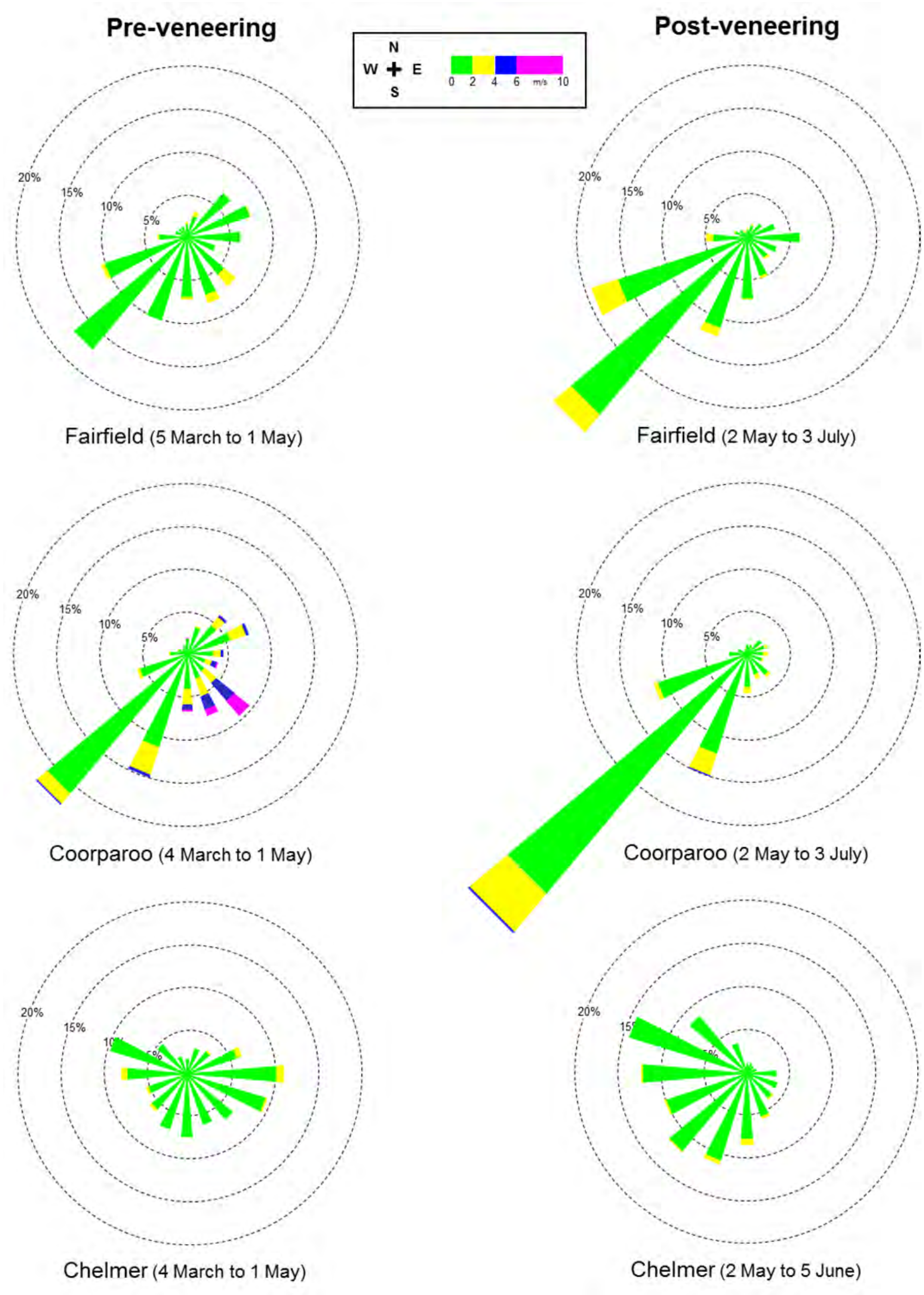

Figure 10: Wind roses at the Fairfield, Coorparoo and Chelmer monitoring sites during the pre-veneering and post-veneering monitoring periods

Winds experienced during the pre-veneering monitoring period meant that highest particle levels would have been expected to occur at the Oakey (South), Willowburn (West), Dinmore (North), Tennyson (North), Fairfield (West) and Coorparoo (North) monitoring locations. At the Chelmer background monitoring site winds blew from the direction of the rail corridor approximately 50 per cent of the time. On this basis, overall measurements at the PM_{10} and $PM_{2.5}$ monitoring sites at Oakey (North), Dinmore (South) and Fairfield (East) may under-represent the impacts of particle emissions from rail corridor traffic. However, all PM_{10} and $PM_{2.5}$ monitoring sites experienced days during the pre-veneering monitoring period when more than 50 per cent of all winds blew from the direction of the rail line towards the monitoring equipment. The frequency of such days ranged from 8 days at the Oakey (North) monitoring site to 50 days at the Tennyson (North) monitoring site.

Winds experienced during the post-veneering monitoring period meant that highest particle levels would have been expected to occur at the Oakey (South), Willowburn (West), Dinmore (North), Tennyson (North), Fairfield (East) and Coorparoo (South) monitoring locations. At the Chelmer background monitoring site winds blew from the direction of the rail corridor approximately 75 per cent of the time. On this basis, overall measurements at the PM_{10} and $PM_{2.5}$ monitoring sites at Oakey (North) and Dinmore (South) may under-represent the impacts of particle emissions from rail corridor traffic. However, all PM_{10} and $PM_{2.5}$ monitoring sites with the exception of Dinmore (South) experienced days during the post-veneering monitoring period when more than 50 per cent of all winds blew from the direction of the rail line towards the monitoring equipment. The frequency of days when more than 50 per cent of all winds blew from the direction of the rail line towards the monitoring equipment ranged from none at the Dinmore (South) monitoring site to 44 days at the Fairfield (East) monitoring site.

The siting of separate deposited dust collection bottles on opposite sides of the rail line meant that any emitted dust would be collected in one of the collection bottles regardless of wind direction at the time of emission.

PM_{10}

Reported PM_{10} values are the total concentrations from all PM_{10} emission sources in proximity to the monitoring sites as described in the earlier discussion on the individual monitoring sites, not just PM_{10} emissions from coal trains and other rail transport.

The 24-hour average PM_{10} monitoring results obtained from the Partisol® instruments at the Oakey, Dinmore, Fairfield, Coorparoo and Chelmer monitoring sites during the pre-veneering and post-veneering monitoring periods are summarised in Table 6 and displayed graphically in Figure 11. Daily measurement data for these sites is provided in Tables 10 to 19 in Appendix 1 of this report. Post-veneering monitoring was conducted for a one-month period at the Oakey, Dinmore and Chelmer monitoring sites and concluded on 2 June. At the Fairfield and Coorparoo monitoring sites where monitoring was extended for a further one-month period due to technical issues experienced with the real-time particle monitoring instruments, PM_{10} monitoring concluded on 2 July.

Figure 11 also shows the proportion of winds blowing from the rail corridor to the sampling site for each sampling day (indicated by the dotted line) and those days when more than 1 mm of rain fell during the day (indicated by the grey columns).

To provide a regional context, summary PM_{10} information for the same periods from a number of DSITIA's South East Queensland ambient monitoring network stations in Brisbane is also included in Table 6. The Rocklea monitoring site is located in a residential/light commercial area. The Wynnum monitoring site is located in a residential area south of the Port of Brisbane. The

Woolloongabba and South Brisbane monitoring sites are located adjacent to major roadways close to the Brisbane central business district.

PM_{10} data availability was greater than 70 per cent for all monitoring sites except Oakey (post-veneering), Dinmore (pre-veneering) and Coorparoo (post-veneering). Across the monitoring sites, there was sufficient data available on each day to adequately assess PM_{10} levels in the rail corridor. Loss of PM_{10} samples occurred as a result of the new filter cartridge jamming during the daily automatic filter exchange process. When this happened the sampler ceased to operate until the jam was cleared by DSITIA field staff on the next site visit. This problem occurred repeatedly at the Oakey site during the latter part of the pre-veneering period and during the post-veneering period, at the Dinmore site during the pre-veneering period, and at the Coorparoo site during the second month of post-veneering monitoring, resulting in extended periods of data loss. A replacement Partisol® sampler was installed at the Dinmore site on 7 April.

During the pre- and post-veneering monitoring periods the EPP Air 24-hour PM_{10} objective of 50 µg/m^3 was not exceeded at any of the rail corridor monitoring sites.

During the pre-veneering monitoring period the highest 24-hour average PM_{10} concentration was 32.2 µg/m^3 (64 per cent of the EPP Air objective) measured at the Chelmer background monitoring site on 12 March. The highest 24-hour average PM_{10} concentration measured at one of the monitoring sites situated on the rail corridor used by coal trains was 28.5 µg/m^3 (57 per cent of the EPP Air objective) at the Fairfield (East) monitoring site on 28 March. On this day winds blew from the direction of the rail corridor towards the monitoring site for 33 per cent of the day and coincided with the passage of four loaded and three unloaded coal trains.

During the post-veneering monitoring period the highest 24-hour average PM_{10} concentration was 38.5 µg/m^3 (77 per cent of the EPP Air objective) measured at the Fairfield (East) monitoring site on 3 May. On this day winds blew from the direction of the rail corridor towards the monitoring site for only 25 per cent of the day and coincided with the passage of three loaded and six unloaded coal trains.

The PM_{10} concentrations measured at Metropolitan rail system monitoring sites during the pre- and post-veneering periods were considerably less than those previously measured at the Tennyson (North) monitoring site during dry conditions in September and October 2012[14], confirming the anticipated impact of the wet conditions on ambient PM_{10} levels during this investigation period.

[14] Department of Science, Information Technology, Innovation and the Arts, *Tennyson Dust Monitoring Investigation September to October 2012*, available at http://www.ehp.qld.gov.au/air/pdf/tennyson-dust-report.pdf, December 2012, accessed 22 July 2013.

Table 6: 24-hour average PM_{10} concentration statistics at the rail corridor monitoring sites during the pre- and post-veneering monitoring periods, March to July 2013.

Monitoring site	Veneering period	24-hour PM_{10} concentration ($\mu g/m^3$)				Number of 24-hour samples
		Average	Median	Maximum	Minimum	
The Environmental Protection Policy (Air) 2008 objective for PM_{10} is 50 $\mu g/m^3$ averaged over a 24 hour period.						
Rail corridor monitoring sites (coal trains)						
Oakey (North)	Pre-veneering (7 March – 1 May)	11.2	9.9	21.9	4.8	43 (77%)
	Post-veneering (2 May – 2 June)	14.2	14.3	23.4	5.2	17 (53%)
Dinmore (South)	Pre-veneering (7 March – 1 May)	14.0	13.0	25.8	7.4	23 (41%)
	Post-veneering (2 May – 2 June)	14.9	12.7	30.7	7.3	29 (91%)
Fairfield (East)	Pre-veneering (6 March – 1 May)	15.8	15.0	28.5	9.1	44 (77%)
	Post-veneering (2 May - 2 July)	13.4	12.2	38.5	3.8	54 (87%)
Coorparoo (North)	Pre-veneering (5 March – 1 May)	15.4	14.8	26.5	6.6	53 (91%)
	Post-veneering (2 May - 2 July)	12.7	11.0	29.6	5.0	43 (69%)
Rail corridor background monitoring site (no coal trains)						
Chelmer	Pre-veneering (5 March – 1 May)	14.7	13.9	32.2	9.5	41 (71%)
	Post-veneering (2 May – 2 June)	12.3	11.2	26.7	4.1	31 (97%)
DSITIA ambient air quality monitoring network sites in Brisbane						
Rocklea	Pre-veneering (5 March – 1 May)	14.6	13.8	22.5	9.5	35 (60%)
	Post-veneering (2 May – 2 July)	9.1	8.8	17.9	2.9	60 (97%)
Woolloongabba	Pre-veneering (5 March – 1 May)	16.1	15.8	28.5	6.5	51 (88%)
	Post-veneering (2 May – 2 July)	11.1	10.4	23.3	1.5	46 (74%)
South Brisbane	Pre-veneering (5 March – 1 May)	18.2	18.2	31.7	8.8	58 (100%)
	Post-veneering (2 May – 2 July)	14.0	13.3	25.8	6.8	59 (95%)
Wynnum	Pre-veneering (5 March – 1 May)	15.0	14.1	41.3	6.6	58 (100%)
	Post-veneering (2 May – 2 July)	13.8	13.3	30.0	4.8	62 (100%)

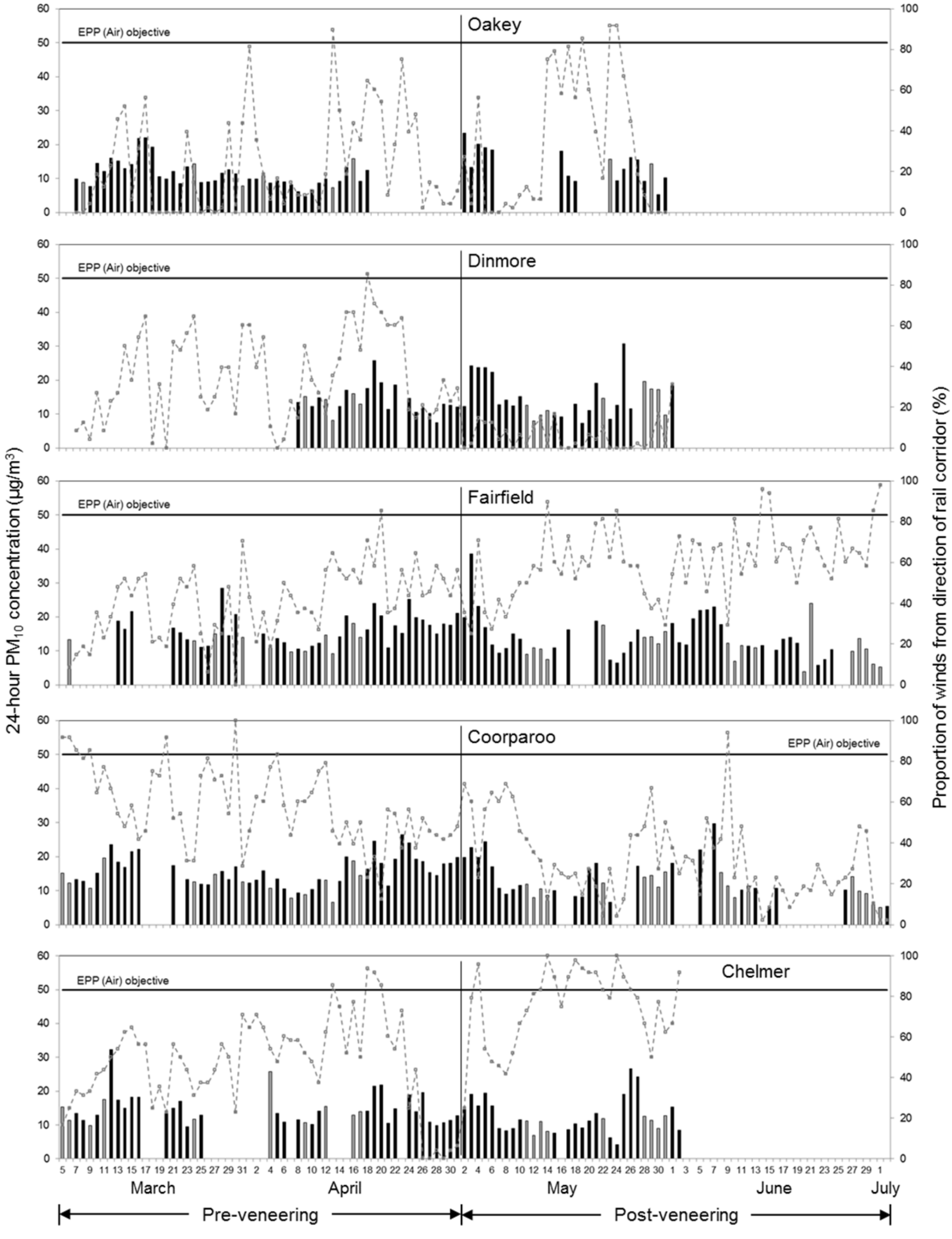

Figure 11: 24-hour average PM_{10} concentrations (shown as columns) and proportion of winds from the direction of the rail line (shown by the dotted line) at the rail corridor monitoring sites during the pre-veneering and post-veneering monitoring periods, March to July 2013. The grey columns indicate days when more than 1mm of rain fell. The vertical line indicates the start of the post-veneering monitoring period.

Average PM_{10} concentrations over the pre-veneering monitoring period were 30 per cent or less of the EPP Air 24-hour objective. Average PM_{10} concentrations over the post-veneering monitoring period increased at the Oakey and Dinmore monitoring sites, but decreased at the Fairfield, Coorparoo and Chelmer monitoring sites. However, the observed decrease in average PM_{10} levels at the Fairfield and Coorparoo sites cannot be attributed to the commencement of coal wagon veneering, as a similar decrease was observed at the Chelmer background monitoring site and at DSITIA ambient air monitoring network sites in Brisbane (see Figure 12). The lack of a consistent trend across all rail corridor monitoring sites means that it is unlikely that the increase observed at the Oakey and Dinmore sites during the post-veneering monitoring period is primarily related to rail transport emissions.

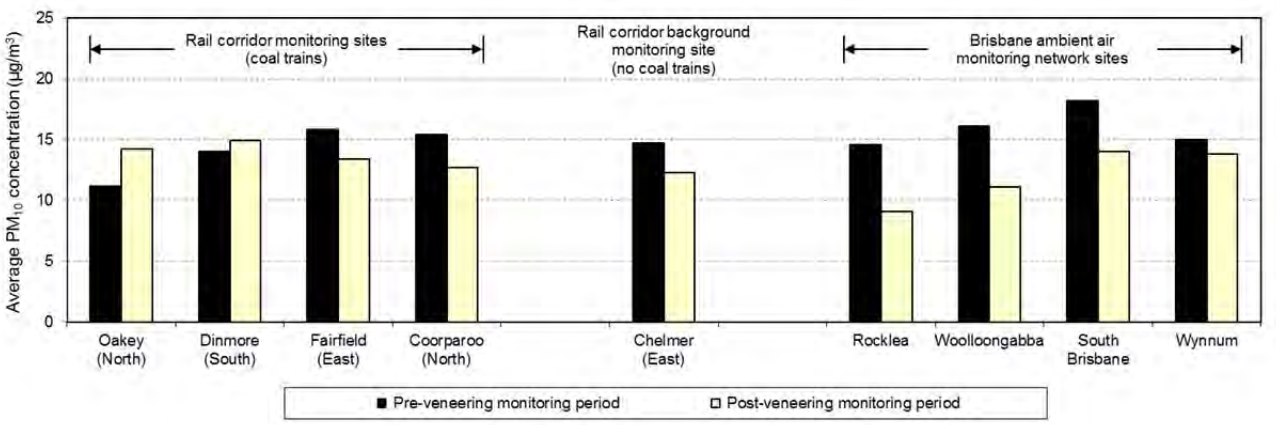

Figure 12: Average PM_{10} concentrations at the rail corridor and DSITIA ambient air quality monitoring network sites in Brisbane during the pre- and post-veneering monitoring periods, March to July 2013.

Analysis of the pre- and post-veneering PM_{10} datasets using a range of non-parametric and parametric statistical tests was undertaken to determine if the introduction of veneering had resulted in any measurable change in 24-hour average PM_{10} concentrations[15]. It was found that any impact from veneering was less than the day-to-day variability in PM_{10} concentrations which, when viewed in conjunction with the observations discussed below, suggests that coal trains are not a major contributor to overall PM_{10} levels at the rail corridor monitoring sites.

There was a close correlation between the PM_{10} levels measured at the Metropolitan rail system rail corridor monitoring sites and those measured at DSITIA ambient air quality monitoring network sites in Brisbane located away from the rail corridor used by coal trains during both the pre- and post-veneering monitoring periods. This indicates that regional urban PM_{10} sources are a significant contributor to PM_{10} levels measured along the rail corridor.

This is further supported by considering the PM_{10} measurements obtained at the monitoring sites on days when no coal trains were operating. During the pre-veneering monitoring period, no coal trains and ten or less freight services travelled past the monitoring stations over the Easter long weekend (Friday 29 to Sunday 31 March) and the weekend of 20 and 21 April. The average PM_{10} concentrations measured at the monitoring sites over these days — 10.6 µg/m^3 at Oakey (29-31 March only), 15.3 µg/m^3 at Dinmore (20 and 21 April only), 16.1 µg/m^3 at Fairfield, 14.4 µg/m^3 at Coorparoo and 16.2 µg/m^3 at Chelmer (20 and 21 April only) — were very similar to the average values measured over the entire pre-veneering period (see Figure 12). During the post-veneering monitoring period, no coal trains operated on Sunday 16 June. The 24-hour average PM_{10}

[15] Non-parametric statistical tests included Friedman and Kruskal-Wallis tests. The parametric statistical test was a generalised least squares model which allowed for autoregressive correlations between observations within a site and included an overall effect of rain (2 level factor), wind (variable) and veneering (2 level factor) and site.

concentrations at the Fairfield and Coorparoo monitoring sites on this day were 10.1 µg/m^3 and 10.7 µg/m^3 respectively, again quite similar to the average concentrations measured over the entire post-veneering monitoring period at these sites.

While there was a small increase in winds from the rail corridor at the Oakey (North) site during the post-veneering monitoring period, highest daily PM_{10} measurements tended to occur on days with a lower proportion of winds from the direction of the rail corridor (see Figure 11). This suggests that rail transport emissions were not the only factor responsible for the increased average PM_{10} level recorded at the Oakey site during the post-veneering monitoring period. The increase in average PM_{10} concentration measured at the Dinmore (South) monitoring site during the post-veneering monitoring period can be attributed to a greater impact from motor vehicle emissions. During this period over 90 per cent of all winds came from the direction of Brisbane Road and the Cunningham Highway rather than from the rail corridor.

The relationship between 24-hour PM_{10} concentrations and the proportion of winds blowing from the direction of the rail line at the five rail corridor monitoring sites over the pre- and post-veneering monitoring periods is plotted in Figure 13. To minimise the impact of dust suppression due to rain, days when more than 5 mm of rain fell have been excluded from this analysis. The heavy dotted lines show the underlying trend for the pre-veneering monitoring period at each monitoring site. The heavy solid lines show the underlying trend for the post-veneering monitoring period at each monitoring site.

During the pre-veneering monitoring period a small positive relationship between winds from the direction of the rail corridor and PM_{10} concentrations was seen at all sites except Coorparoo. The maximum trend was a 1.2 µg/m^3 increase in PM_{10} for each 10 per cent increase in winds from the direction of the rail corridor at the Dinmore monitoring site. During the post-veneering monitoring period a small positive relationship was seen at the Dinmore and Coorparoo sites, while the remaining sites displayed a small negative relationship. The maximum trend was again observed at the Dinmore monitoring site where there was a 1.7 µg/m^3 increase in PM_{10} for each 10 per cent increase in winds from the direction of the rail corridor. While train movements may contribute to PM_{10} concentrations in the vicinity of the rail corridor, these results are consistent with previous observations that other urban PM_{10} sources such as motor vehicle emissions transported from roads upwind of the monitoring site appear to be the major influence on measured PM_{10} levels. The roads around the Dinmore monitoring site have the highest traffic density, and the highest proportion of heavy vehicles, of all the rail corridor monitoring sites, so it is not surprising that this site displayed the most significant relationship trend.

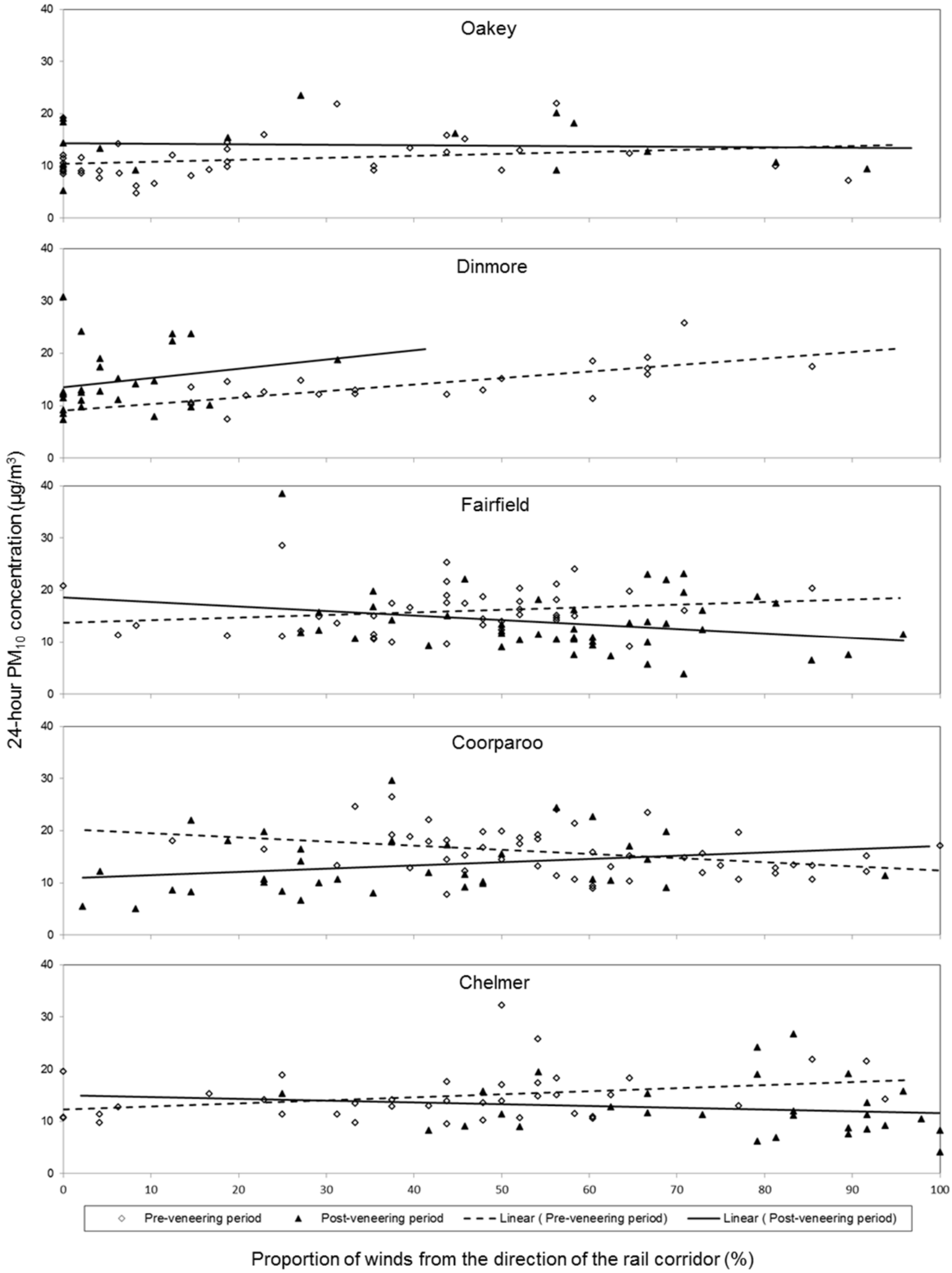

Figure 13: Relationship between 24-hour average PM_{10} concentrations and proportion of winds from the direction of the rail line at the rail corridor monitoring sites during the pre-veneering and post-veneering monitoring periods, March to July 2013. The heavy dotted line shows the underlying trend during the pre-veneering period. The heavy solid line shows the underlying trend during the post-veneering period.

$PM_{2.5}$

Reported $PM_{2.5}$ values are the total concentrations from all $PM_{2.5}$ emission sources in proximity to the monitoring sites as described in the earlier discussion on the individual monitoring sites, not just $PM_{2.5}$ emissions from coal trains and other rail transport.

The 24-hour average $PM_{2.5}$ monitoring results obtained from the Partisol® instruments at the Oakey, Dinmore, Fairfield, Coorparoo and Chelmer monitoring sites during the pre-veneering and post-veneering monitoring periods are summarised in Table 7 and displayed graphically in Figure 14. Daily measurement data for these sites is provided in Tables 20 to 29 in Appendix 1 of this report. Post-veneering monitoring was conducted for a one-month period at the Oakey, Dinmore and Chelmer monitoring sites and concluded on 2 June. At the Fairfield and Coorparoo monitoring sites where monitoring was extended for a further one-month period due to technical issues experienced with the real-time particle monitoring instruments, $PM_{2.5}$ monitoring concluded on 2 July.

Figure 14 also shows the proportion of winds blowing from the rail corridor to the sampling site for each sampling day (indicated by the dotted line) and those days when more than 1 mm of rain fell during the day (indicated by the grey columns). To provide a regional context, summary $PM_{2.5}$ information for the same periods from a number of DSITIA's South East Queensland ambient monitoring network stations in Brisbane is also included in Table 7.

$PM_{2.5}$ data availability was greater than 70 per cent for all monitoring sites except Oakey (post-veneering), Dinmore (pre-veneering) and Chelmer (post-veneering). Across the monitoring sites, there was sufficient data available on each day to adequately assess $PM_{2.5}$ levels in the rail corridor. $PM_{2.5}$ data for the Dinmore (South) site may not be representative of the overall pre-veneering period due to the low number of $PM_{2.5}$ samples collected. Loss of $PM_{2.5}$ samples occurred as a result of the new filter cartridge jamming during the daily automatic filter exchange process. When this happened the sampler ceased to operate until the jam was cleared by DSITIA field staff on the next site visit. This problem occurred repeatedly at the Oakey site during the latter part of the pre-veneering period and during the post-veneering period, at the Dinmore site during the pre-veneering period, and at the Chelmer site during the post-veneering period, resulting in extended periods of data loss. A replacement dichotomous sampler was installed at the Dinmore site on 23 April.

During the pre- and post-veneering monitoring periods the EPP Air 24-hour $PM_{2.5}$ objective of 25 µg/m^3 was not exceeded at any of the rail corridor monitoring sites. Average $PM_{2.5}$ concentrations over the pre- and post-veneering monitoring periods were less than the EPP Air annual objective value of 8 µg/m^3, although the monitoring periods were insufficient to confirm compliance with this objective.

During the pre-veneering monitoring period the highest 24-hour average $PM_{2.5}$ concentration was 23.2 µg/m^3 (93 per cent of the EPP Air objective) measured at the Coorparoo (North) site on 19 March. On this day winds blew from the direction of the rail corridor towards the monitoring site for 73 per cent of the day and coincided with the passage of 12 loaded and 10 unloaded coal trains.

The highest average $PM_{2.5}$ concentration over the pre-veneering monitoring period was 7.1 µg/m^3 (89 per cent of the EPP Air annual objective) at the Chelmer background monitoring site. The highest average $PM_{2.5}$ concentration at one of the monitoring sites situated on the rail corridor used by coal trains over the pre-veneering monitoring period was 7.0 µg/m^3 (88 per cent of the EPP Air annual objective) at the Coorparoo (North) site.

Table 7: 24-hour average $PM_{2.5}$ concentration statistics at the rail corridor monitoring sites during the pre- and post-veneering monitoring periods, March to July 2013.

Monitoring site	Veneering period	24-hour $PM_{2.5}$ concentration (µg/m³)				Number of 24-hour samples
		Average	Median	Maximum	Minimum	
The Environmental Protection Policy (Air) 2008 objectives for $PM_{2.5}$ are 8 µg/m³ averaged over one year and 25 µg/m³ averaged over a 24 hour period.						
Rail corridor monitoring sites (coal trains)						
Oakey (North)	Pre-veneering (7 March – 1 May)	3.6	3.5	8.2	1.6	43 (77%)
	Post-veneering (2 May – 2 June)	5.4	5.7	9.1	2.2	17 (53%)
Dinmore (South)	Pre-veneering (7 March – 1 May)	5.3	5.2	7.9	3.5	8 (14%)
	Post-veneering (2 May – 2 June)	5.7	5.4	10.1	3.0	29 (91%)
Fairfield (East)	Pre-veneering (6 March – 1 May)	6.6	6.2	13.6	3.2	56 (98%)
	Post-veneering (2 May - 2 July)	6.1	6.0	11.0	0.3	46 (74%)
Coorparoo (North)	Pre-veneering (5 March – 1 May)	7.0	6.4	23.2	2.9	49 (84%)
	Post-veneering (2 May - 2 July)	6.2	6.0	11.3	1.9	59 (95%)
Rail corridor background monitoring site (no coal trains)						
Chelmer	Pre-veneering (5 March – 1 May)	7.1	6.6	16.4	3.9	41 (71%)
	Post-veneering (2 May – 2 June)	5.6	5.9	8.3	2.7	18 (56%)
DSITIA ambient air quality monitoring network sites in Brisbane						
Rocklea	Pre-veneering (5 March – 1 May)	6.3	6.2	10.6	2.6	35 (60%)
	Post-veneering (2 May – 2 July)	4.8	4.7	9.1	1.2	60 (97%)
Woolloongabba	Pre-veneering (5 March – 1 May)	7.6	7.4	16.5	2.5	51 (88%)
	Post-veneering (2 May – 2 July)	6.6	6.4	12.7	0.0	55 (89%)
South Brisbane	Pre-veneering (5 March – 1 May)	6.9	6.5	17.1	2.5	58 (100%)
	Post-veneering (2 May – 2 July)	7.1	6.9	12.7	3.7	59 (95%)
Wynnum	Pre-veneering (5 March – 1 May)	3.9	3.4	12.9	1.2	58 (100%)
	Post-veneering (2 May – 2 July)	3.7	3.6	7.4	0.5	57 (92%)

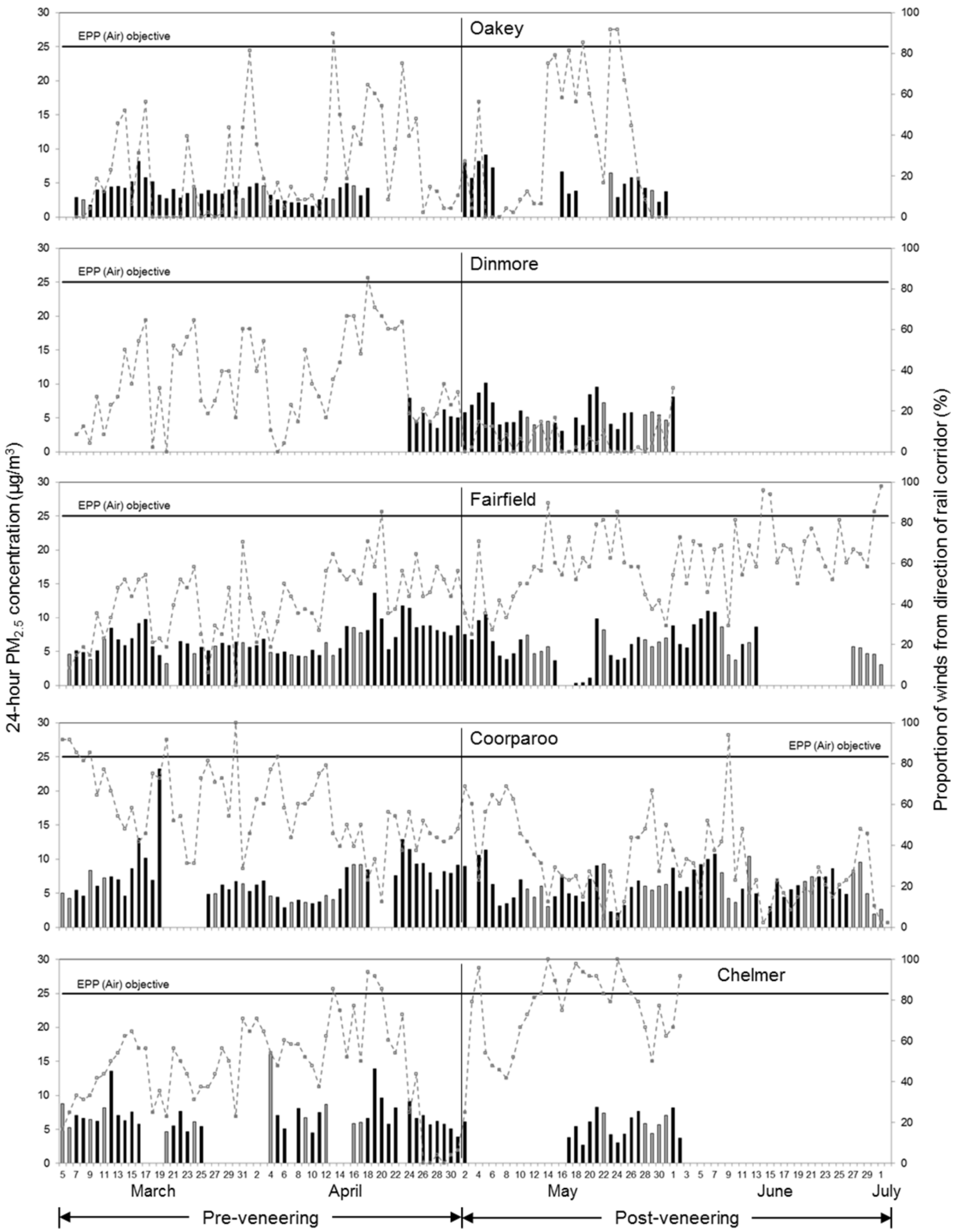

Figure 14: 24-hour average $PM_{2.5}$ concentrations (shown as columns) and proportion of winds from the direction of the rail line (shown by the dotted line) at the rail corridor monitoring sites during the study period, March to July 2013. The grey columns indicate days when more than 1mm of rain fell. The vertical line indicates the start of the post-veneering monitoring period.

During the post-veneering monitoring period the highest 24-hour average $PM_{2.5}$ concentration was 11.3 µg/m^3 (45 per cent of the EPP Air objective) measured at the Coorparoo (North) monitoring site on 5 May. On this day winds blew from the direction of the rail corridor towards the monitoring site for 56 per cent of the day and coincided with the passage of four loaded and five unloaded coal trains.

The highest average $PM_{2.5}$ concentration over the post-veneering monitoring period was 6.2 µg/m^3 (78 per cent of the EPP Air annual objective) at the Coorparoo (North) site.

Average $PM_{2.5}$ concentrations over the post-veneering monitoring period increased compared to the pre-veneering monitoring period at the Oakey and Dinmore monitoring sites, but decreased at the Fairfield, Coorparoo and Chelmer monitoring sites. However, the observed decrease in average $PM_{2.5}$ levels at the Fairfield and Coorparoo sites cannot be attributed to the commencement of coal wagon veneering, as a corresponding decrease was observed at the Chelmer background monitoring site and at the majority of DSITIA ambient monitoring network sites in Brisbane (Figure 15). The lack of a consistent trend across all rail corridor monitoring sites means that it is unlikely that the increase observed at the Oakey and Dinmore sites during the post-veneering monitoring period was primarily related to rail transport emissions.

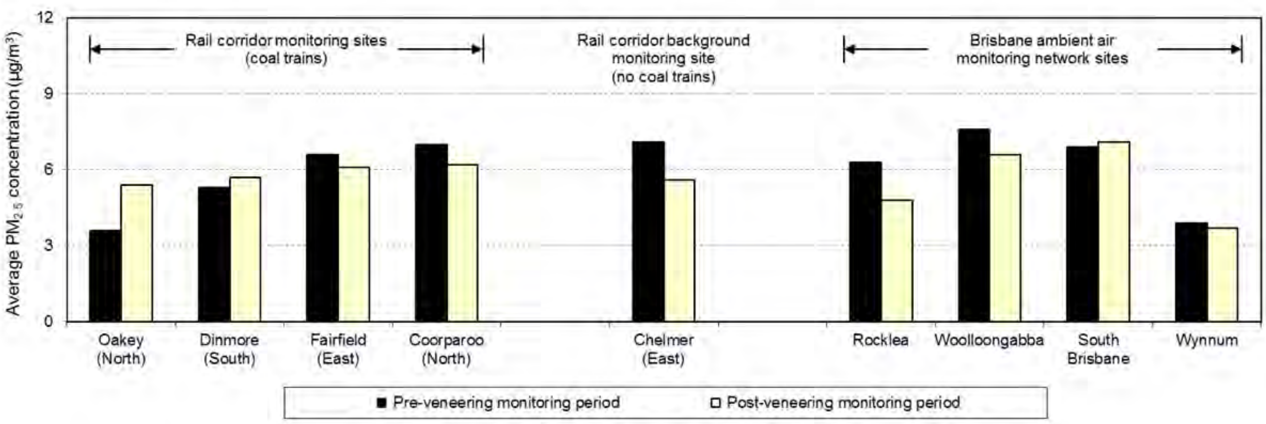

Figure 15: Average $PM_{2.5}$ concentrations at the rail corridor and Brisbane ambient air quality monitoring network sites during the pre- and post-veneering monitoring periods, March to July 2013.

Analysis of the pre- and post-veneering $PM_{2.5}$ datasets using a range of non-parametric and parametric statistical tests was undertaken to determine if the introduction of veneering had resulted in any measurable change in 24-hour average $PM_{2.5}$ concentrations[16]. It was found that any impact from veneering was less than the day-to-day variability in $PM_{2.5}$ concentrations which, when viewed in conjunction with the observations discussed below, suggests that coal trains are not a major contributor to overall $PM_{2.5}$ levels at the rail corridor monitoring sites.

As with PM_{10}, there was a close comparison between the $PM_{2.5}$ levels measured at the Metropolitan rail system rail corridor monitoring sites and those measured at DSITIA ambient monitoring network sites in Brisbane located away from the rail corridor used by coal trains during both the pre- and post-veneering monitoring periods. This, coupled with the fact that the Chelmer background site measured the highest average $PM_{2.5}$ concentration during the pre-veneering monitoring period, indicates that regional urban $PM_{2.5}$ sources are a potentially more significant contributor to $PM_{2.5}$ levels measured along the rail corridor.

[16] Non-parametric statistical tests included Friedman and Kruskal-Wallis tests. The parametric statistical test was a generalised least squares model which allowed for autoregressive correlations between observations within a site and included an overall effect of rain (2 level factor), wind (variable) and veneering (2 level factor) and site

This is further supported by considering the $PM_{2.5}$ measurements obtained at the monitoring sites on days when no coal trains were operating. During the pre-veneering monitoring period, no coal trains and ten or less freight services travelled past the monitoring stations over the Easter long weekend (Friday 29 to Sunday 31 March) and the weekend of 20 and 21 April. The average $PM_{2.5}$ concentrations measured at the monitoring sites over these days — 3.7 µg/m^3 at Oakey (29-31 March only), 6.7 µg/m^3 at Fairfield, 6.2 µg/m^3 at Coorparoo (29-31 March only) and 7.7 µg/m^3 at Chelmer (20 and 21 April only) — were very similar to the average values measured over the entire pre-veneering period (Figure 15). No data was available for Dinmore as the $PM_{2.5}$ sampler was not operating on these days. During the post-veneering monitoring period, no coal trains operated on Sunday 16 June. The 24-hour average $PM_{2.5}$ concentration at the Coorparoo monitoring site on this day was 7.0 µg/m^3, which was slightly higher than the average concentration measured over the entire post-veneering monitoring period at this site. No data was available for Fairfield as the $PM_{2.5}$ sampler was not operating on this day.

While there was a small increase in winds from the rail corridor at the Oakey (North) site during the post-veneering monitoring period, highest daily $PM_{2.5}$ measurements tended to occur on days with a lower proportion of winds from the direction of the rail corridor (see Figure 14). This suggests that rail transport emissions were not the only factor responsible for the increased average $PM_{2.5}$ level recorded at the Oakey site during the post-veneering monitoring period. The increase in average $PM_{2.5}$ concentration measured at the Dinmore (South) monitoring site during the post-veneering monitoring period can be attributed to a greater impact from motor vehicle emissions. During this period over 90 per cent of all winds were from the direction of Brisbane Road and the Cunningham Highway rather than from the rail corridor.

The relationship between 24-hour $PM_{2.5}$ concentrations and the proportion of winds blowing from the direction of the rail line at the five rail corridor monitoring sites over the pre- and post-veneering monitoring periods is plotted in Figure 16. To minimise the impact of dust suppression due to rain, days when more than 5 mm of rain fell have been excluded from this analysis. The heavy dotted lines show the underlying trend for the pre-veneering monitoring period at each monitoring site. The heavy solid lines show the underlying trend for the post-veneering monitoring period at each monitoring site.

During the pre-veneering monitoring period a small positive relationship between winds from the direction of the rail corridor and $PM_{2.5}$ concentrations was seen at all sites except Coorparoo. The maximum trend was a 0.7 µg/m^3 increase in $PM_{2.5}$ for each 10 per cent increase in winds from the rail corridor at the Fairfield monitoring site. During the post-veneering monitoring period a small positive relationship was seen at the Dinmore site (1.1 µg/m^3 increase in $PM_{2.5}$ for each 10 per cent increase in winds from the direction of the rail corridor), while the remaining sites displayed a small negative relationship. While train movements may contribute to $PM_{2.5}$ concentrations in the vicinity of the rail corridor, these results are consistent with previous observations that other urban $PM_{2.5}$ sources such as motor vehicle emissions from roads upwind of the monitoring site appear to be the major influence on measured $PM_{2.5}$ levels. The roads around the Dinmore monitoring site have the highest traffic density, and the highest proportion of heavy vehicles, of all the rail corridor monitoring sites, so it is not surprising that this site displayed the most significant relationship trend.

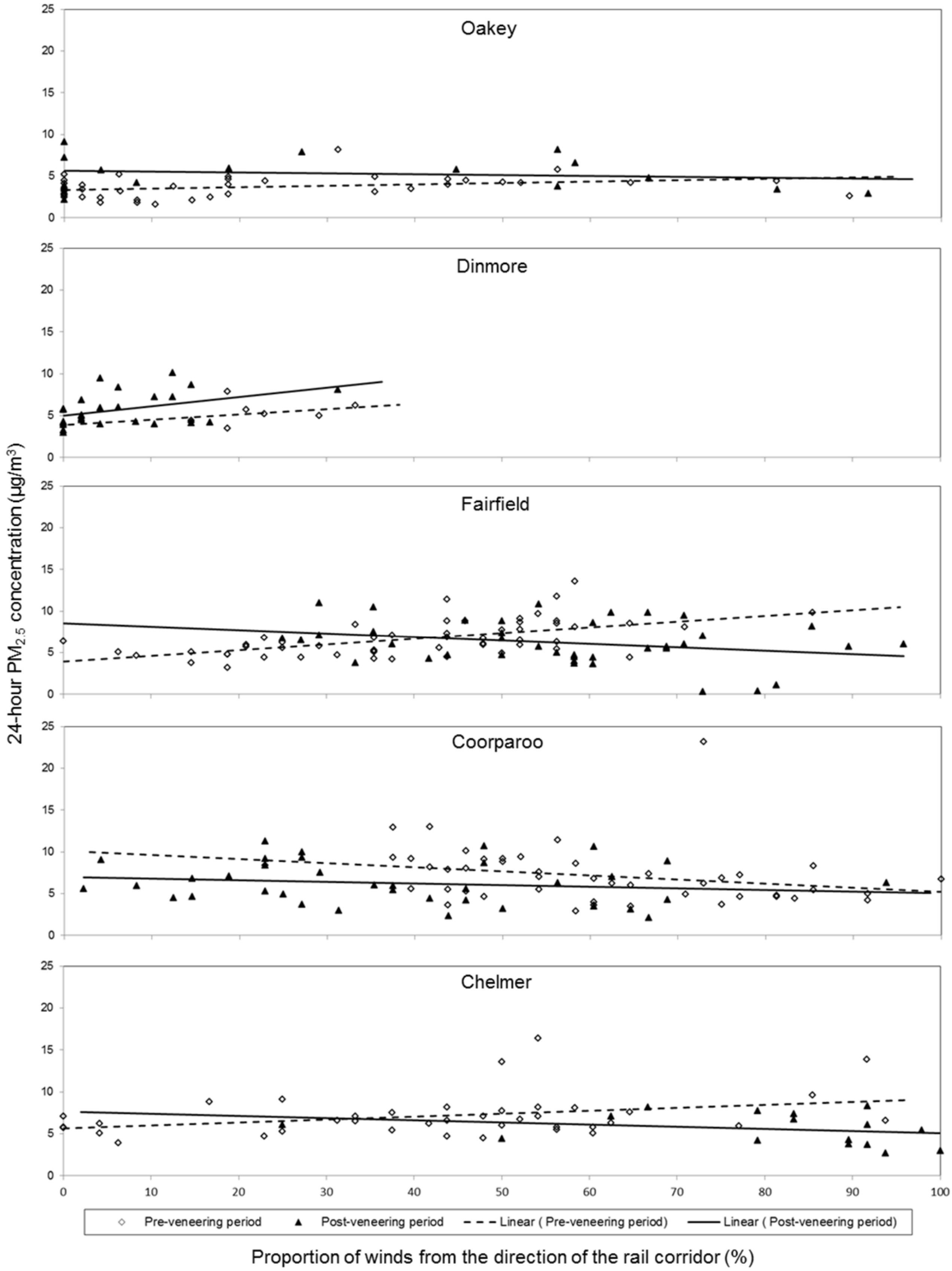

Figure 16: Relationship between 24-hour average $PM_{2.5}$ concentrations and proportion of winds from the direction of the rail line at the rail corridor monitoring sites during the pre-veneering and post-veneering monitoring periods, March to June 2013. The heavy dotted line shows the underlying trend for the pre-veneering period. The heavy solid line shows the underlying trend for the post-veneering period.

Deposited dust

In this investigation amenity degradation was evaluated by measuring dust deposition, or the amount of dust settling from the air at the monitoring sites. Sampling was conducted at each of the seven rail corridor monitoring sites. The dust fallout levels were assessed against criteria for dust annoyance. No health-based ambient air quality guidelines exist for deposited matter.

Dust that settles from the air is made up almost entirely of larger particles 30 micrometres and greater in diameter[17].

Reported dust deposition values are the combined total from all dust emission sources in proximity to the monitoring sites as described in the earlier discussion on the individual monitoring sites, not just dust emissions from coal trains and other rail transport.

The dust deposition analysis method allows for the determination of total, dissolved and insoluble deposited matter, with a further breakdown of the insoluble fraction into combustible (organic) matter and ash (mineral) content. Insoluble matter is the solid material collected by filtering the sample, while the dissolved matter is determined by evaporating some or all of the liquid filtrate. As a general rule, the dissolved material is of little interest in assessing nuisance effects. In a coastal environment a large proportion of the dissolved matter would be marine salt. ‘Combustible (organic) matter’ is that portion of the insoluble matter lost on heating at a temperature of 850^{o}C for 30 minutes and is an indication of the amount of organic material in the dust. Any coal particles present in the insoluble deposited dust will be part of this organic matter fraction, along with other organic material such as plant fragments, insect material, plastic fragments, wood dust, soot and rubber dust. The ash content is an indication of the mineral content of the dust. The ash is often primarily soil or rock particles.

Two monthly dust deposition samples were collected at each of the seven monitoring sites during the pre-veneering monitoring period from March into early May 2013. The Willowburn (East) and Willowburn (West) samples collected during March had to be invalidated due to extensive algal growth in the collected solution.

A single monthly sample was collected at the Oakey, Willowburn, Dinmore and Chelmer monitoring from May into early June 2013 following the commencement of coal wagon veneering at the New Hope Mine. With the decision to extend the post-veneering monitoring at the Tennyson, Fairfield and Coorparoo sites for a further month, two monthly dust deposition samples were collected at these sites during the post-veneering monitoring period from May into early July 2013.

The results of dust deposition sampling at the rail corridor monitoring sites for the combined two monthly samples collected during the pre-veneering monitoring period and the one sample, or combined two monthly samples, collected during the post-veneering monitoring period are summarised in Table 8 and displayed graphically in Figures 17 to 23. In Figures 17 to 23 the contributions from combustible (organic) matter particle types and ash (mineral) particle types to the overall insoluble dust deposition rate are shown by the divisions on each column, and the proportion of winds blowing from the direction of the rail corridor during the sampling period is shown by the dotted line. Details of the individual monthly dust deposition samples and analysis results can be found in Table 30 in Appendix 1 of this report.

[17] J.H. Fairweather, A.F. Sidlow and W.L. Faith, *Particle size distribution of settled dust*, Journal of the Air Pollution Control Association, 15:8, 345-347, 1965, available at http://dx.doi.org/10.1080/00022470.1965.10468389, accessed 29 August 2013.

Table 8: Average daily dust deposition rates ($mg/m^2/day$) measured at the rail corridor monitoring sites during the pre- and post-veneering monitoring periods, March to July 2013.

Monitoring site	Position relative to rail line	Veneering period	Dust deposition[a] ($mg/m^2/day$)			Winds from direction of rail line (%)	Rainfall (mm)[b]
			Insoluble solids	Ash (mineral)	Combustible (organic) matter		
Rail corridor monitoring sites (coal trains)							
Oakey	North	Pre	32	7	25	23	62
		Post	17	17	0	34	39
	South	Pre	62	10	52	77	62
		Post	33	26	7	66	39
Willowburn (Toowoomba)	East	Pre	25	5	20	19	24
		Post	33	13	20	32	74
	West	Pre	11	4	7	81	24
		Post	14	7	7	68	74
Dinmore	North	Pre	52	23	29	62	152
		Post	20	10	10	90	46
	South	Pre	58	8	50	34	152
		Post	37	17	20	6	46
Tennyson	North	Pre	104	22	82	78	162
		Post	30	20	10	88	129
	South	Pre	103	20	83	22	162
		Post	57	45	12	14	129
Fairfield	East	Pre	33	9	24	41	172
		Post	32	12	10	61	144
	West	Pre	85	18	67	61	172
		Post	26	12	14	40	144
Coorparoo	North	Pre	107	10	97	58	185
		Post	26	14	12	31	140
	South	Pre	114	8	106	29	185
		Post	24	10	14	44	140
Rail corridor background monitoring site (no coal trains)							
Chelmer	East	Pre	53	5	48	46	166
		Post	36	13	23	77	52

[a] Ash deposition rate plus combustible (organic) matter deposition rate equals insoluble solids deposition rate.
[b] Indicative only - estimated from the volume of water collected in the dust deposition bottle.

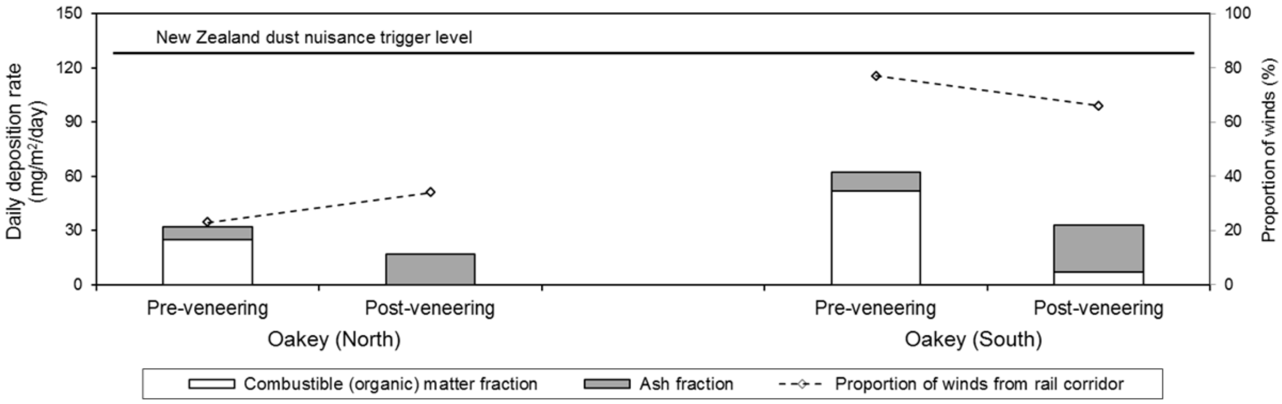

Figure 17: Insoluble dust deposition rates at the Oakey monitoring sites during the pre- and post-veneering monitoring periods, March to June 2013.

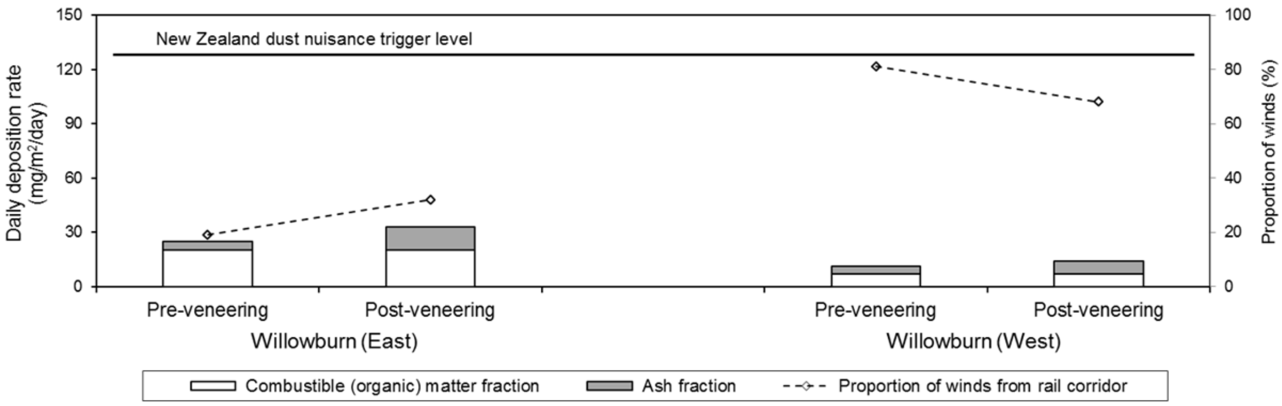

Figure 18: Insoluble dust deposition rates at the Willowburn (Toowoomba) monitoring sites during the pre- and post-veneering monitoring periods, March to June 2013.

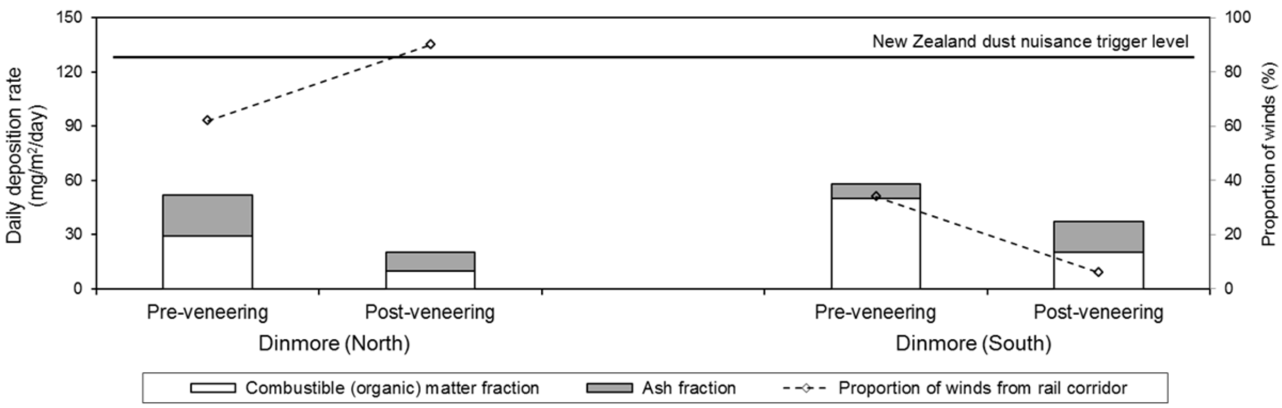

Figure 19: Insoluble dust deposition rates at the Dinmore monitoring sites during the pre- and post-veneering monitoring periods, March to June 2013.

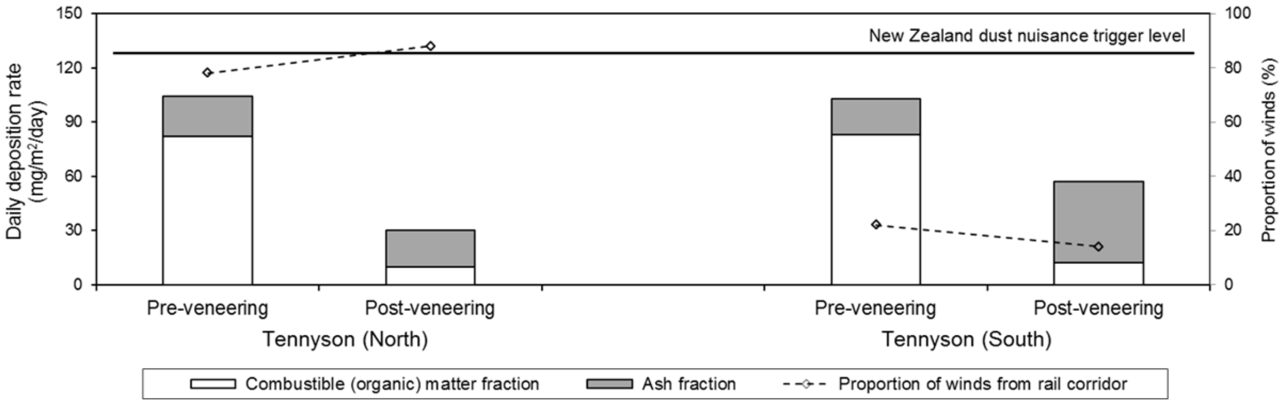

Figure 20: Insoluble dust deposition rates at the Tennyson monitoring sites during the pre- and post-veneering monitoring periods, March to July 2013.

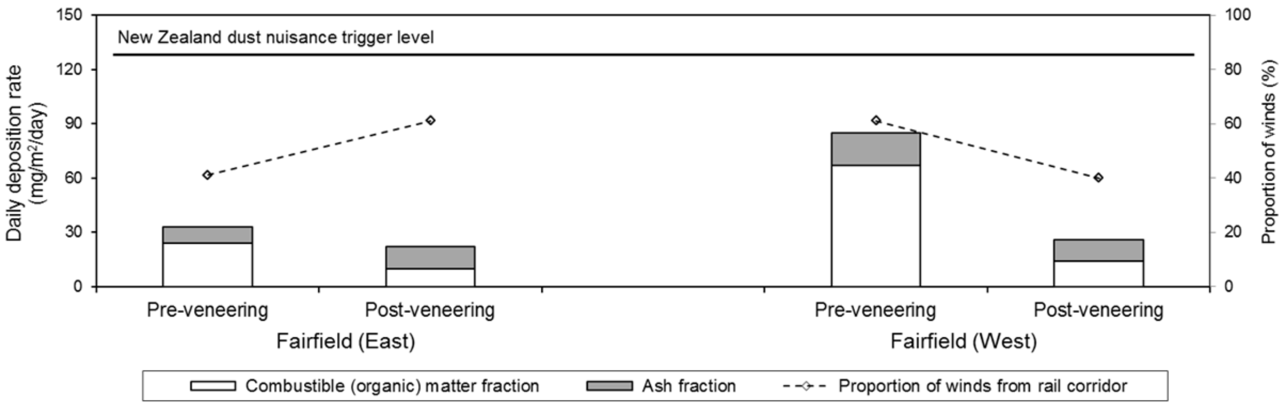

Figure 21: Insoluble dust deposition rates at the Fairfield monitoring sites during the pre- and post-veneering monitoring periods, March to July 2013.

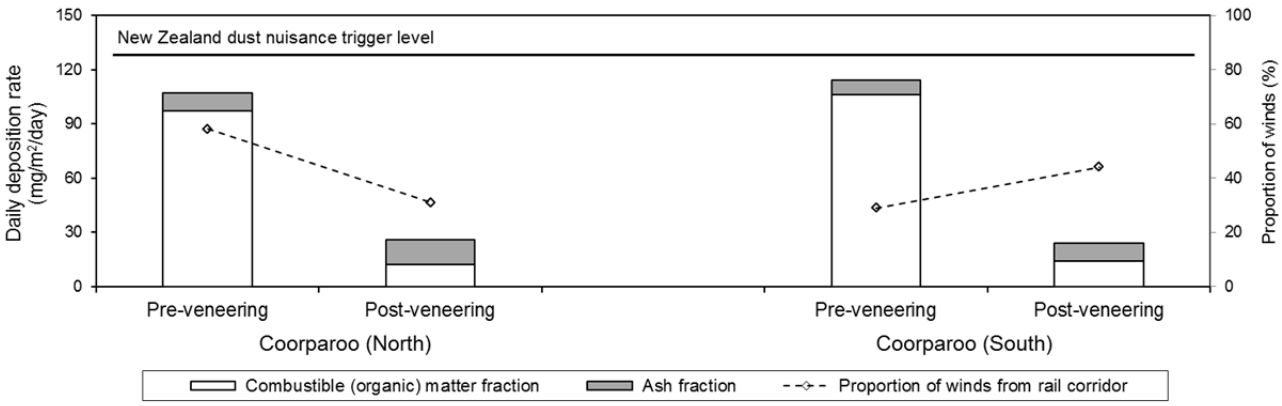

Figure 22: Insoluble dust deposition rates at the Coorparoo monitoring sites during the pre- and post-veneering monitoring periods, March to July 2013.

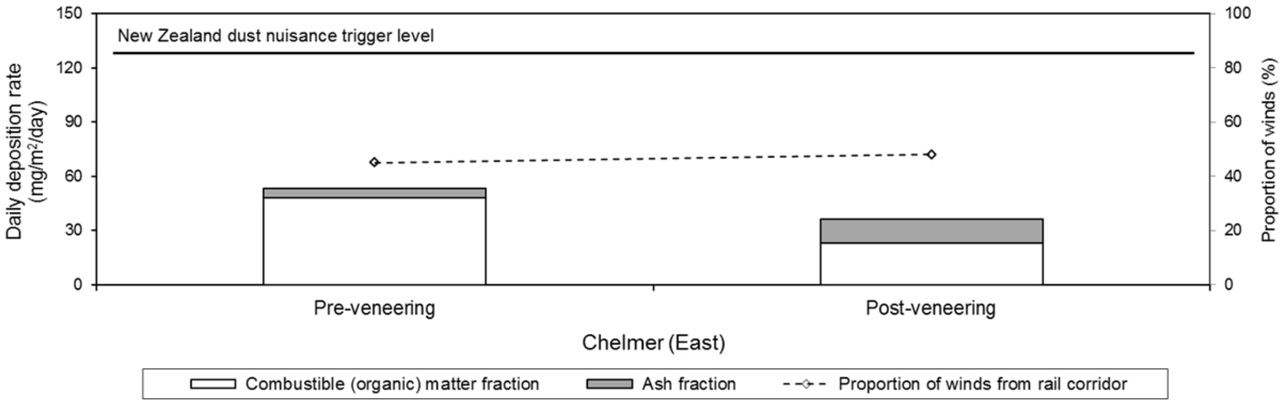

Figure 23: Insoluble dust deposition rates at the Chelmer background monitoring site during the pre- and post-veneering monitoring periods, March to June 2013.

The New Zealand dust nuisance trigger level value of 130 mg/m^2/day was not exceeded at any of the rail corridor monitoring sites during the pre- or post-veneering monitoring periods. The maximum daily average insoluble dust deposition rate measured during the pre-veneering period was 114 mg/m^2/day at the Coorparoo (South) monitoring site. The maximum daily average insoluble dust deposition rate measured during the post-veneering period was 57 mg/m^2/day at the Tennyson (South) monitoring site.

With the exception of a small increase seen at the Willowburn monitoring site, there was a reduction in the deposition rate of insoluble particulate matter at all other monitoring sites following the commencement of coal wagon veneering at the start of May 2013. Results from the Chelmer background monitoring site suggest that, for metropolitan Brisbane monitoring sites at least, some of this reduction is likely to be a result of lower background dust levels.

However, the apparent improvement in dust deposition rates at the rail corridor monitoring sites following the commencement of coal wagon veneering at the New Hope Mine needs to be qualified by the fact a number of the deposited dust results during the pre-veneering monitoring period showed a very high proportion of organic matter in the insoluble solids fraction (up to 93 per cent by weight). Previous monitoring at sites along the rail corridor in 1999 and again in 2012 found combustible (organic) matter typically comprised only 20 to 60 per cent of total insoluble solids[18,19]. When the pre-veneering deposited dust samples were collected it was noted at the time that many samples contained considerable amounts of non-representative biological debris such as whole and parts of insects and plant matter. It would appear that this non-representative material has contributed to the combustible (organic) matter (and hence overall insoluble solids) results. Deposited dust samples where organic matter makes up almost all the insoluble solids will be an overestimation of actual ambient deposited dust levels experienced during the pre-veneering monitoring period.

[18] SIMTARS, *Coal Dust Monitoring: West Ipswich to Fisherman Islands – Queensland Rail Twelve Month Summary Report*, File Reference 50/003/50/1/16, 1999.

[19] Department of Science, Information Technology, Innovation and the Arts, *Tennyson Dust Monitoring Investigation September to October 2012*, available at http://www.ehp.qld.gov.au/air/pdf/tennyson-dust-report.pdf, December 2012, accessed 22 July 2013.

Dust composition

One of the aims of the coal dust monitoring program was to obtain a measure of the contribution of coal dust to overall dust levels in the community. Microscopic analysis of a sample of the deposited dust was undertaken to determine the type of particles present in the deposited dust and their relative proportions. The dust composition analysis was undertaken using the deposited dust for two reasons: firstly, coal dust particles lost from rail wagons during transport would be expected to be predominantly larger than PM_{10} in size and, as such, would end up in the deposited dust sample and, secondly, the filter medium used by the PM_{10} and $PM_{2.5}$ samplers is not suitable for the microscope technique used to distinguish the types of particles present as the sampled particles become imbedded within the filter and are not able to be quantitatively identified.

The dust composition analysis was performed by filtering the sub-sample taken from the deposited dust collection bottles from each monitoring site through a membrane filter, followed by microscopic examination of the insoluble particles retained on the surface of filter. The microscope techniques used by the University of Queensland's Applied Materials Characterisation and Performance Laboratory were capable of distinguishing a number of different types of particles in the deposited dust. The particle types able to be identified included a range of black-coloured particles (coal, soot and rubber dust), mineral dust (e.g. soil, rock, fly ash, cement, glass), biological particles (e.g. insect and plant fragments) and other general organic particles (e.g. wood, fibres, paint, plastics).

The relative proportions of the different particles present in the dust sample were based on the surface area coverage of each particle type on the membrane filter. The microscope techniques were capable of resolving the relative surface area proportions of the different particle types to an accuracy of between 5 and 10 per cent. As the particle composition analysis is based on surface area coverage and the dust deposition rate analysis is based on particle mass, it is not possible to derive a quantitative deposition rate for individual particle types from the particle composition analysis results.

Table 9 summarises the relative proportions (based on coverage of the filter surface area) of those particles found to be present across all the deposited dust samples collected at the rail corridor monitoring sites during the pre- and post-veneering monitoring periods. Details of the composition results for the individual monthly dust deposition samples can be found in Table 31 in Appendix 1 of this report.

The relative proportions of the different particle types present in the deposited dust samples at each monitoring site during the pre- and post-veneering monitoring periods are displayed graphically in Figures 24 to 30.

Some samples were found to contain copper sludge due to the addition of copper sulfate to the dust deposition bottle prior to sampling to control the growth of algae in the collection bottle during the sampling period as specified by the requirements of the Australian Standard method. The presence of copper sludge does not indicate a source of airborne copper compounds at these locations. For samples found to contain copper sludge, the copper sludge percentage was deducted and the remaining component percentages factored up to total of 100 per cent for comparison with the remaining samples in Figures 24 to 30. The proportion of winds blowing from the direction of the rail corridor during the sampling period is shown by the dotted line in Figures 24 to 30.

Table 9: Composition of the deposited dust insoluble solids fraction at the rail corridor monitoring sites during the pre- and post-veneering monitoring periods, March to July 2013.

Monitoring site	Position relative to rail line	Veneering period	Surface coverage (%)[a]									
			Black particles			Inorganic and minerals		Biological			General organic	
			Coal	Soot	Black rubber dust	Soil or rock dust	Copper sludge	Photosynthetic slime and fungi	Insect debris	Plant debris (general)	Fibres (miscellaneous)	Paint
Rail corridor monitoring sites (coal trains)												
Oakey	North	Pre	15	ND	7	58	15	ND	trace	5	ND	ND
		Post	10	trace	10	80	trace	ND	trace	trace	ND	ND
	South	Pre	10	trace	10	60	20	ND	trace	trace	ND	ND
		Post	20	trace	10	70	ND	ND	trace	trace	ND	ND
Willowburn (Toowoomba)	East	Pre	10	trace	ND	60	ND	ND	20	10	ND	ND
		Post	trace	ND	ND	20	ND	60	20	ND	ND	ND
	West	Pre	10	trace	10	80	ND	ND	trace	trace	ND	ND
		Post	5	trace	10	75	ND	ND	10	trace	ND	ND
Dinmore	North	Pre	15	ND	10	65	10	ND	trace	trace	trace	ND
		Post	10	trace	30	60	trace	ND	trace	trace	ND	ND
	South	Pre	20	ND	10	50	ND	ND	10	10	ND	ND
		Post	10	trace	trace	80	trace	ND	10	trace	ND	ND
Tennyson	North	Pre	10	ND	15	55	15	ND	trace	5	ND	ND
		Post	15	trace	15	65	5	ND	trace	trace	trace	ND
	South	Pre	10	trace	10	70	trace	ND	trace	10	ND	trace
		Post	8	trace	5	87	trace	ND	trace	trace	trace	ND
Fairfield	East	Pre	10	trace	10	70	trace	ND	trace	10	ND	ND
		Post	5	trace	15	80	trace	ND	trace	trace	trace	ND
	West	Pre	10	trace	10	60	ND	ND	5	15	trace	trace
		Post	8	trace	10	82	trace	ND	trace	trace	trace	ND
Coorparoo	North	Pre	5	trace	10	70	trace	ND	5	10	ND	ND
		Post	13	ND	15	72	trace	ND	trace	trace	trace	ND
	South	Pre	20	trace	10	55	ND	ND	trace	15	trace	trace
		Post	10	trace	20	65	trace	ND	5	trace	trace	ND
Rail corridor background monitoring site (no coal trains)												
Chelmer	East	Pre	ND	trace	ND	65	ND	10	10	15	trace	ND
		Post	trace	trace	10	90	trace	ND	trace	trace	trace	ND

[a] The uncertainty in the measurement of surface coverage is ±5 per cent
ND = not detected

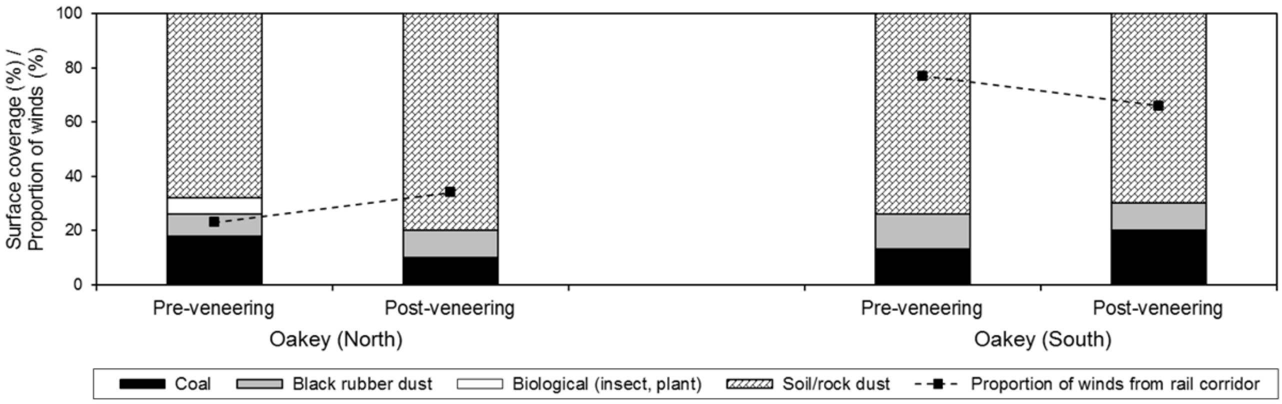

Figure 24: Relative proportions of the different particle types present in the deposited dust samples at the Oakey monitoring sites during the pre- and post-veneering monitoring periods, March to June 2013.

Figure 25: Relative proportions of the different particle types present in the deposited dust samples at the Willowburn (Toowoomba) monitoring sites during the pre- and post-veneering monitoring periods, March to June 2013.

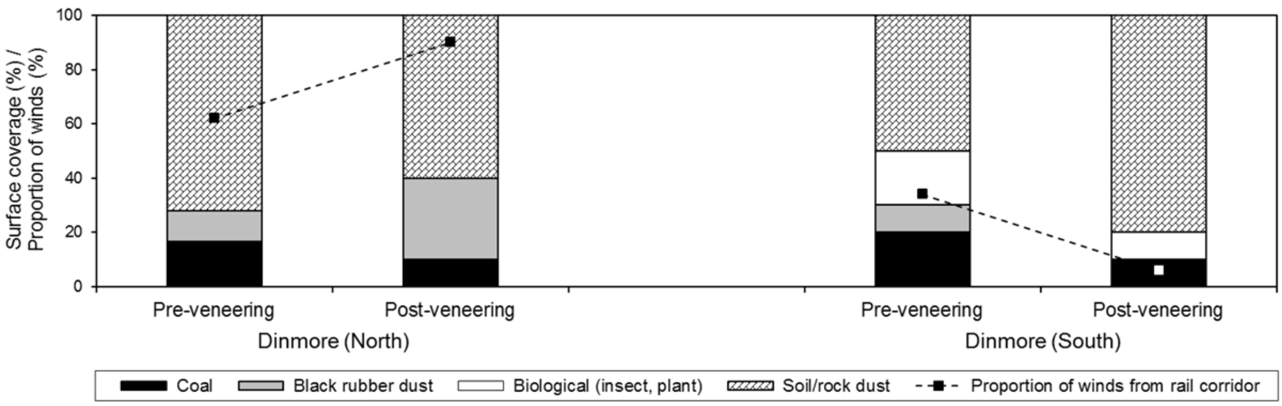

Figure 26: Relative proportions of the different particle types present in the deposited dust samples at the Dinmore monitoring sites during the pre- and post-veneering monitoring periods, March to June 2013.

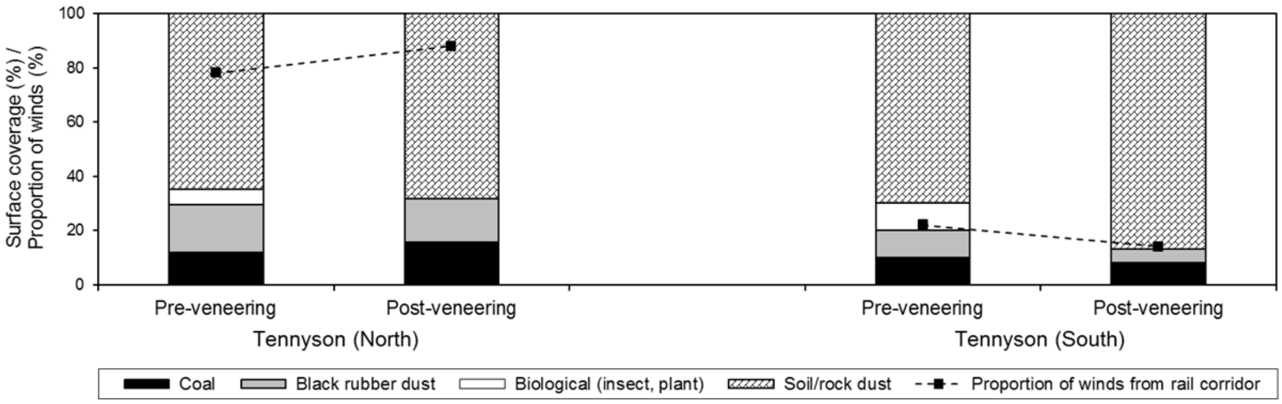

Figure 27: Relative proportions of the different particle types present in the deposited dust samples at the Tennyson monitoring sites during the pre- and post-veneering monitoring periods, March to July 2013.

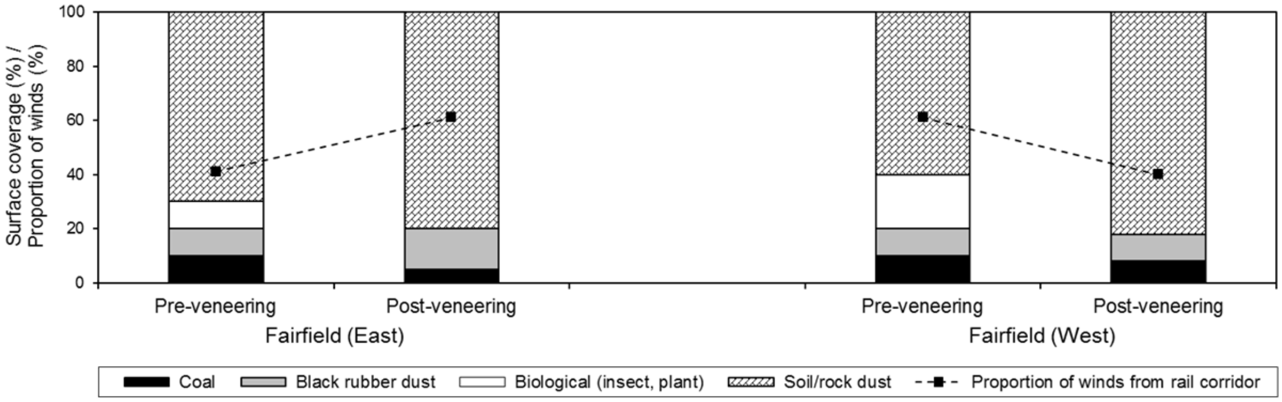

Figure 28: Relative proportions of the different particle types present in the deposited dust samples at the Fairfield monitoring sites during the pre- and post-veneering monitoring periods, March to July 2013.

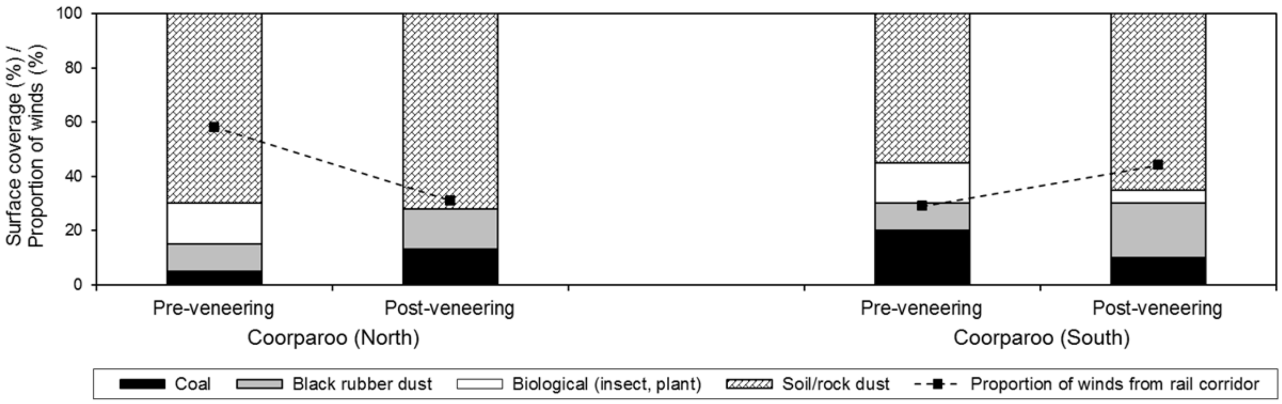

Figure 29: Relative proportions of the different particle types present in the deposited dust samples at the Coorparoo monitoring sites during the pre- and post-veneering monitoring periods, March to July 2013.

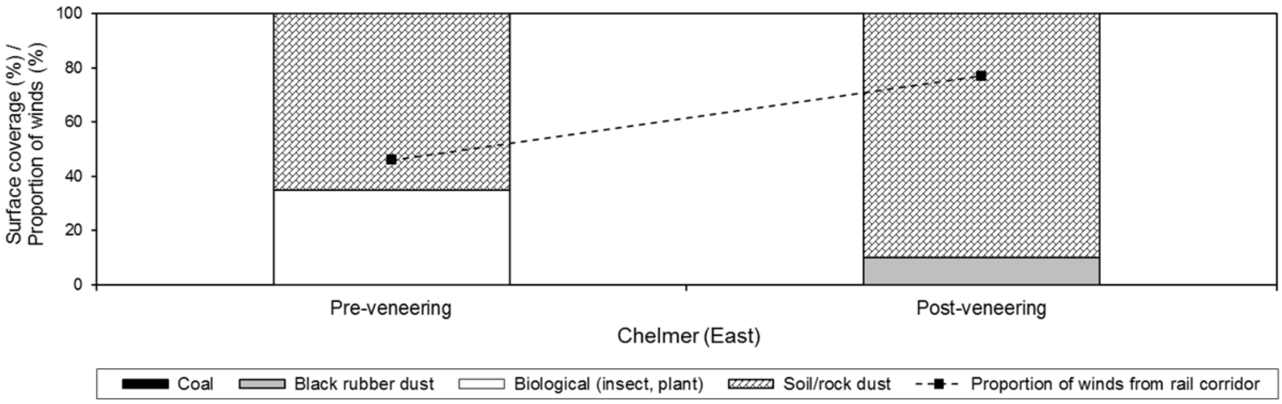

Figure 30: Relative proportions of the different particle types present in the deposited dust samples at the Chelmer background monitoring site during the pre- and post-veneering monitoring periods, March to June 2013.

The major component of the deposited dust at each monitoring site was found to be mineral dust (soil or rock dust), comprising between 50 and 90 per cent of the total deposited dust fraction at each site.

Coal dust was consistently detected in the deposited dust samples collected at monitoring sites situated on the section of the Western-Metropolitan rail corridor used by coal trains. Coal dust typically made up around 10 per cent of the total surface area in the deposited dust samples, with the amount present in individual samples ranging from trace levels up to 20 per cent of the total surface coverage. Coal dust was only detected at trace levels in one of the three deposited dust samples collected at the background monitoring site at Chelmer (Figure 30). As the Chelmer monitoring site was located only 4.5 kilometres from the nearest section of the Metropolitan rail system used by coal trains, this suggests that any dust impacts from coal transport will be localised to the immediate vicinity of the rail corridor used by coal trains and are unlikely to impact significantly on the broader community.

Black rubber dust (generated primarily from vehicle tyre wear during driving) was found at most locations, typically accounting for about 10 per cent of the surface coverage, but up to 30 per cent in one sample at the Dinmore (North) site. Trace levels of soot were observed at most monitoring locations at some time.

Particles of biological origin such as plant debris (e.g. bark, leaf fragments) and insect debris were commonly present at levels between 10 and 20 per cent, and up to 40 per cent in some cases, in samples collected during the pre-veneering monitoring period but were generally only present at trace levels in the post-veneering samples. Other particles observed in trace amounts in some samples were miscellaneous fibres and paint fragments. Some samples contained copper sludge due to the addition of copper sulfate to the dust deposition bottle prior to sampling to control the growth of algae in the collection bottle during the sampling period as specified by the requirements of the Australian Standard method. The presence of copper sludge does not indicate a source of airborne copper compounds at these locations.

The proportion of coal dust found in the pre-veneering monitoring period dust samples (typically between 10 and 20 per cent) were similar to the levels found in a previous study at Tennyson in September and October 2012[20]. Across the rail corridor monitoring sites, a general trend towards

[20] Department of Science, Information Technology, Innovation and the Arts, *Tennyson Dust Monitoring Investigation September to October 2012*, available at http://www.ehp.qld.gov.au/air/pdf/tennyson-dust-report.pdf, December 2012, accessed 22 July 2013.

lower levels of coal dust in the deposited dust was observed following the commencement of rail wagon veneering at the New Hope Mine at the start of May 2013, although this trend was not consistent. While the proportion of coal present in the deposited dust samples remained constant or fell at most monitoring sites, levels increased in the post-veneering monitoring period at the Oakey (South), Tennyson (North) and Coorparoo (North) monitoring sites.

The proportion of coal dust in the deposited dust samples did not show any obvious trend to greater loss with distance travelled from the point of loading in either the pre-veneering or post-veneering samples.

The presence of coal particles in the deposited dust samples will result from two main sources – direct loss from uncovered rail wagons and coal lodged on other rail wagon surfaces as the train passes, and re-entrainment of coal particles previously deposited on the rail track ballast and ground surface within the rail corridor during the passage of trains. Re-entrainment can occur during the passage of any train, not just coal trains. With the implementation of veneering it can be assumed that the direct loss of coal particles from rail wagons should decrease while, at least in the period immediately following the commencement of veneering, the amount of coal being re-entrained (along with soil particles) from within the rail corridor will be largely unchanged (given similar climatic conditions). Evidence of this occurring should be seen as a decrease in the coal to soil particle ratio in the deposited dust samples following veneering, and should continue to decline over time if veneering is effective.

The results of this analysis for the six monitoring sites along the rail corridor used by coal trains are shown in Figures 31 to 36. The proportion of winds blowing from the direction of the rail corridor during the sampling period is shown by the dotted line in Figures 31 to 36.

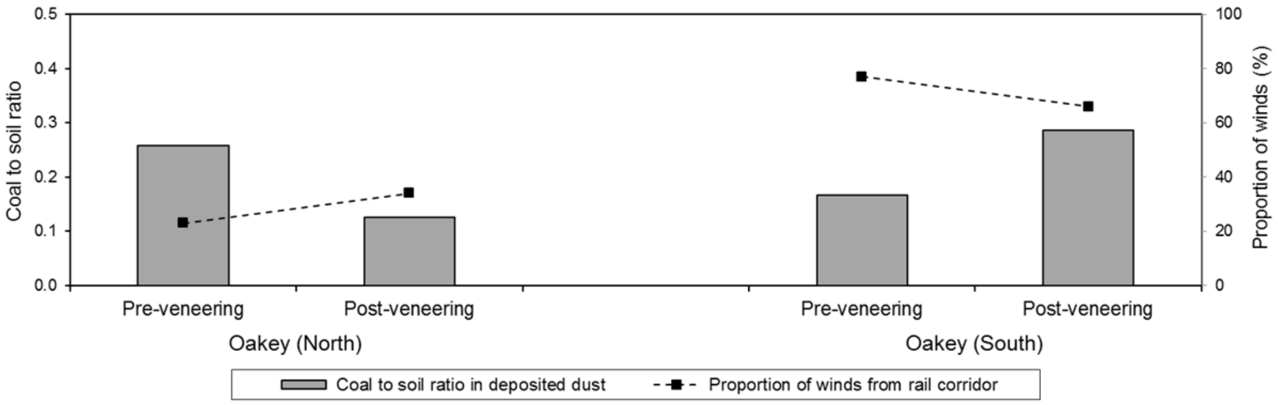

Figure 31: Ratio of coal to soil particles present in the deposited dust samples at the Oakey monitoring sites during the pre- and post-veneering monitoring periods, March to June 2013.

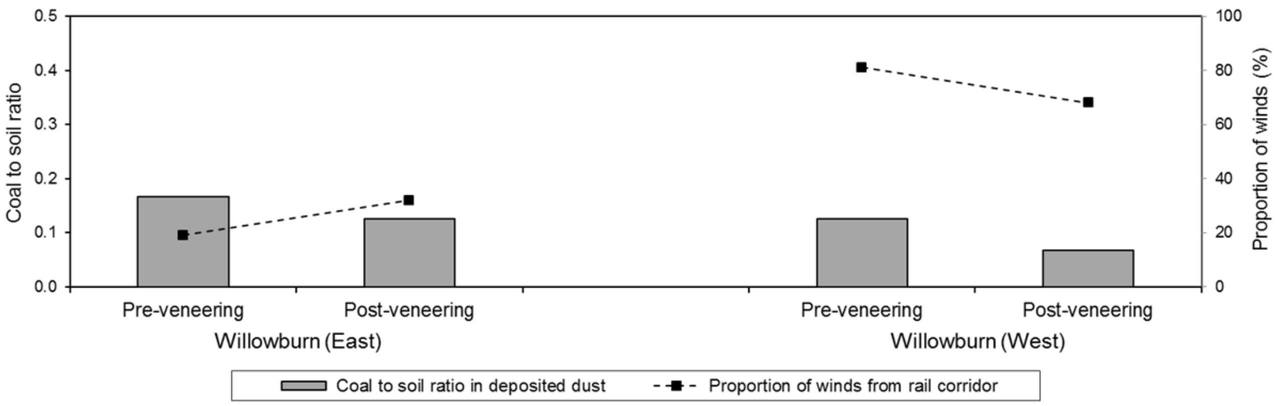

Figure 32: Ratio of coal to soil particles present in the deposited dust samples at the Willowburn monitoring sites during the pre- and post-veneering monitoring periods, March to May 2013.

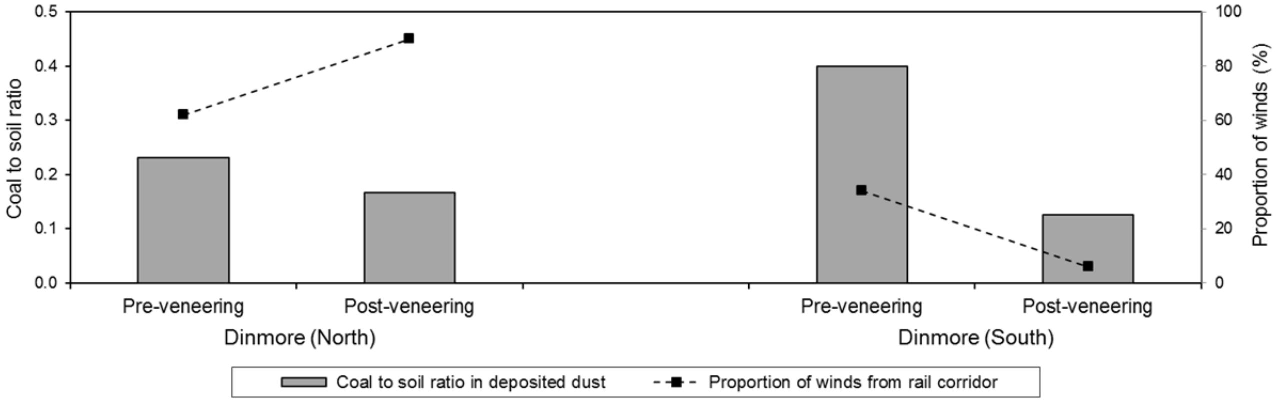

Figure 33: Ratio of coal to soil particles present in the deposited dust samples at the Dinmore monitoring sites during the pre- and post-veneering monitoring periods, March to May 2013.

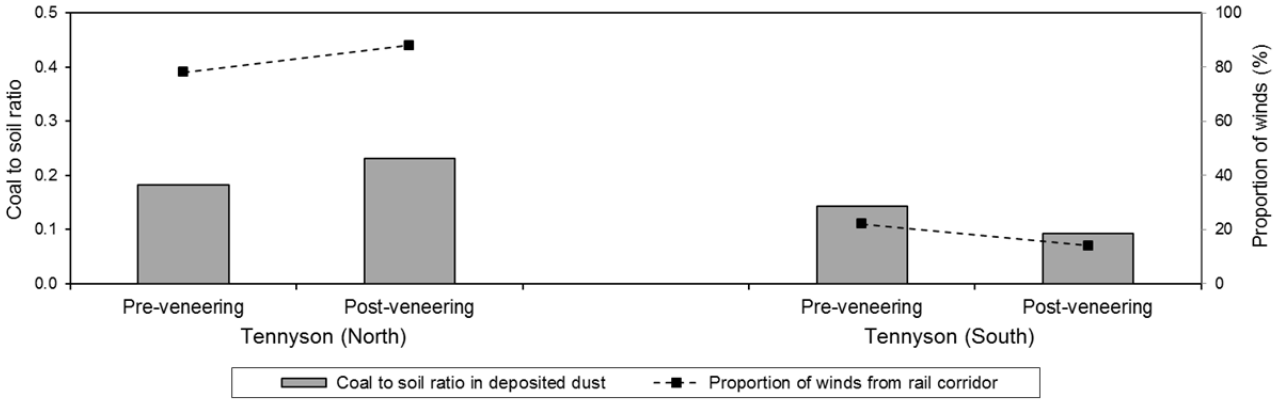

Figure 34: Ratio of coal to soil particles present in the deposited dust samples at the Tennyson monitoring sites during the pre- and post-veneering monitoring periods, March to July 2013.

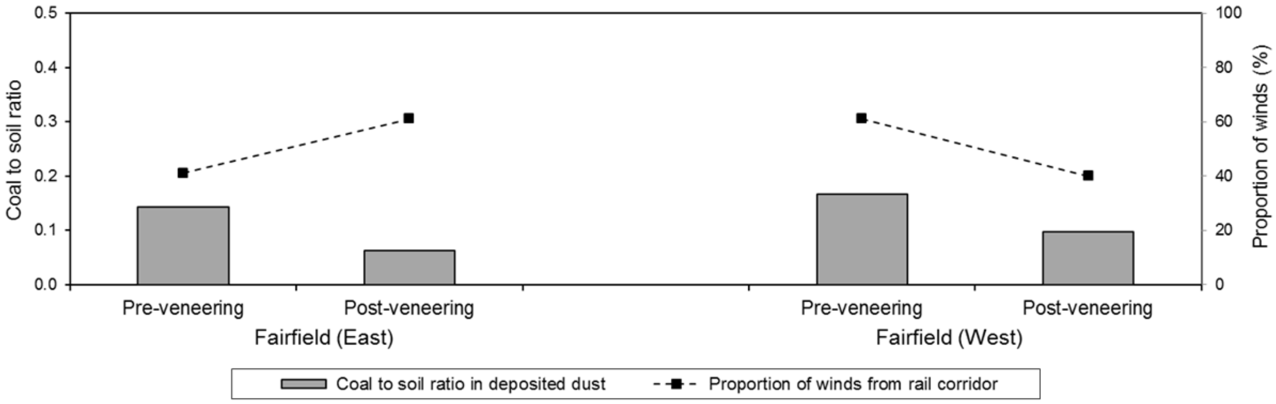

Figure 35: Ratio of coal to soil particles present in the deposited dust samples at the Fairfield monitoring sites during the pre- and post-veneering monitoring periods, March to July 2013.

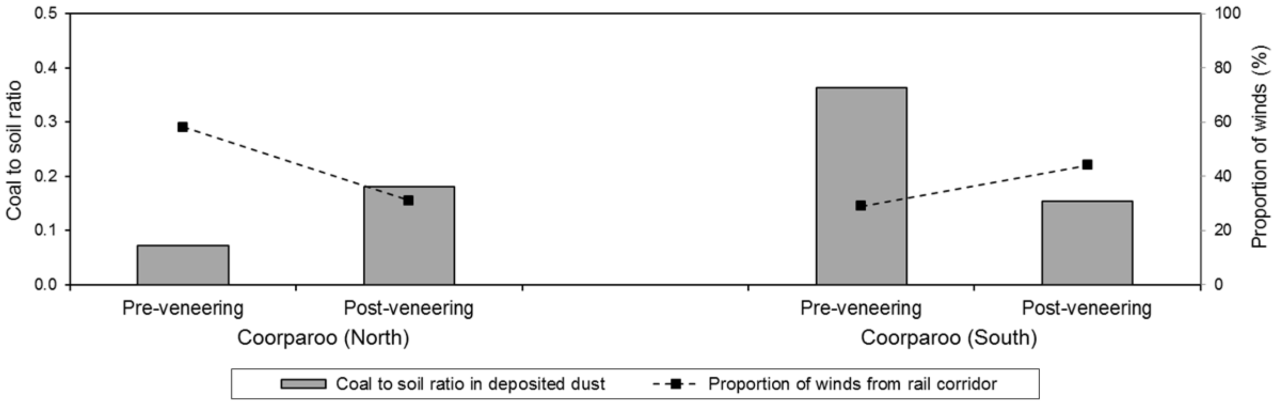

Figure 36: Ratio of coal to soil particles present in the deposited dust samples at the Coorparoo monitoring sites during the pre- and post-veneering monitoring periods, March to July 2013.

From this analysis there is some indication that the ratio of coal to soil particles in the deposited dust samples may have decreased overall following the commencement of rail wagon veneering, however the degree of variability in the individual results highlights a need for further monitoring to confirm this apparent improvement is ongoing.

The general trend towards decreased dust deposition rates and lower levels of coal dust in the deposited dust samples observed at most monitoring sites following the implementation of rail wagon veneering at the New Hope Mine suggests that veneering has reduced the loss of coal particles into the environment during transit. However, as climatic and other factors can significantly influence the results of individual deposited dust samples, monitoring over a period longer than one to two months is necessary in order to clearly demonstrate that veneering is effective in reducing coal loss during transit. The second phase of the Western-Metropolitan Rail Systems Coal Dust Monitoring Program includes collection of deposited dust samples over a 12 month period at one rail corridor monitoring site within Brisbane. This extended monitoring will provide a much clearer picture of the effectiveness of rail wagon veneering in reducing coal dust levels in the surrounding environment. Within this period all coal wagons transporting coal to the Port of Brisbane will be veneered.

Dust levels during train movements

As part of the study, DSITIA was requested to undertake monitoring of the short-term variability in particle levels at three Metropolitan rail line monitoring sites (Tennyson, Fairfield and Coorparoo) to determine if the passage of different train types has any bearing on ambient particle levels. Five-minute average $PM_{2.5}$ and PM_{10} particle concentrations as recorded by the Dusttrak™ instrument were collected to permit this analysis to be carried out.

The methodology used to assess the impact of the passage of different train types on ambient particle levels involved comparing the average total particles concentration measurement during the two five-minute monitoring periods immediately before the passage of an individual train against the corresponding average concentration for the five-minute periods during and immediately following the passage of the train. An averaging period of ten minutes was chosen in order to capture ongoing particle changes at the monitoring sites that may occur after the train had passed. Details of the times of train movements past the monitoring sites during the investigation period were provided by Queensland Rail. To minimise the influence of multiple train movements, only ‘isolated’ train movements where there were no other trains within the 15 minute period before and the ten minute period following the passage of the train were considered in the analysis.

A further step was taken to exclude from the analysis those conditions where any impacts associated with the passage of the train were unlikely to be detected at the monitoring site. Only those ‘isolated’ train movements that took place during calm wind conditions (wind speeds less than 1 m/s) and/or when winds were blowing from the rail line towards the monitoring equipment were included in the analysis.

Unfortunately, no valid Dusttrak™ measurement data was collected at the Fairfield monitoring site during the pre-veneering monitoring period and data collected prior to 16 April at the Coorparoo monitoring site had to be invalidated due to instrument problems which proved difficult to resolve. To increase the overall dataset available for this analysis, DSITIA continued to collect real-time particle data at the three Metropolitan rail system monitoring sites for an additional month following the scheduled end of the post-veneering monitoring period.

During the pre-veneering monitoring period from 5 March to 1 May 2013 there were 3192 train movements past the Tennyson (North) monitoring site. Of these, 1065 (33 per cent) fitted the ‘isolated’ train criteria described above, comprising 310 loaded coal trains, 378 empty coal trains, 271 other freight trains and 106 passenger trains. During the period from 16 April to 1 May 2013 there were 2028 train movements (the majority being electric passenger trains) past the Coorparoo (North) monitoring site. Of these, 505 (25 per cent) fitted the individual train criteria described above, comprising 92 loaded coal trains, 133 empty coal trains, 28 other freight trains and 252 passenger trains.

During the post-veneering monitoring period from 2 May to 2 July 2013 there were 3256 train movements past the Tennyson (North) monitoring site. Of these, 571 (18 per cent) fitted the ‘isolated’ train criteria described above, comprising 196 loaded coal trains, 205 empty coal trains, 131 other freight trains and 39 passenger trains. There were 13 560 train movements (the majority being electric passenger trains) past the Fairfield (East) monitoring site. Of these, 283 (2 per cent) fitted the ‘isolated’ train criteria described above, comprising 65 loaded coal trains, 73 empty coal trains, 41 other freight trains and 104 passenger trains. There were 8120 train movements (the majority being electric passenger trains) past the Coorparoo (North) monitoring site. Of these, 458 (6 per cent) fitted the ‘isolated’ train criteria described above, comprising 94 loaded coal trains, 138 empty coal trains, 23 other freight trains and 203 passenger trains.

The results of the analysis of the changes in PM_{10} and $PM_{2.5}$ levels coinciding with train passing the monitoring site are displayed graphically for the three monitoring sites in Figures 37 to 42. Tables 32 to 37 in Appendix 1 of this report contain the frequency distribution values shown in these graphs.

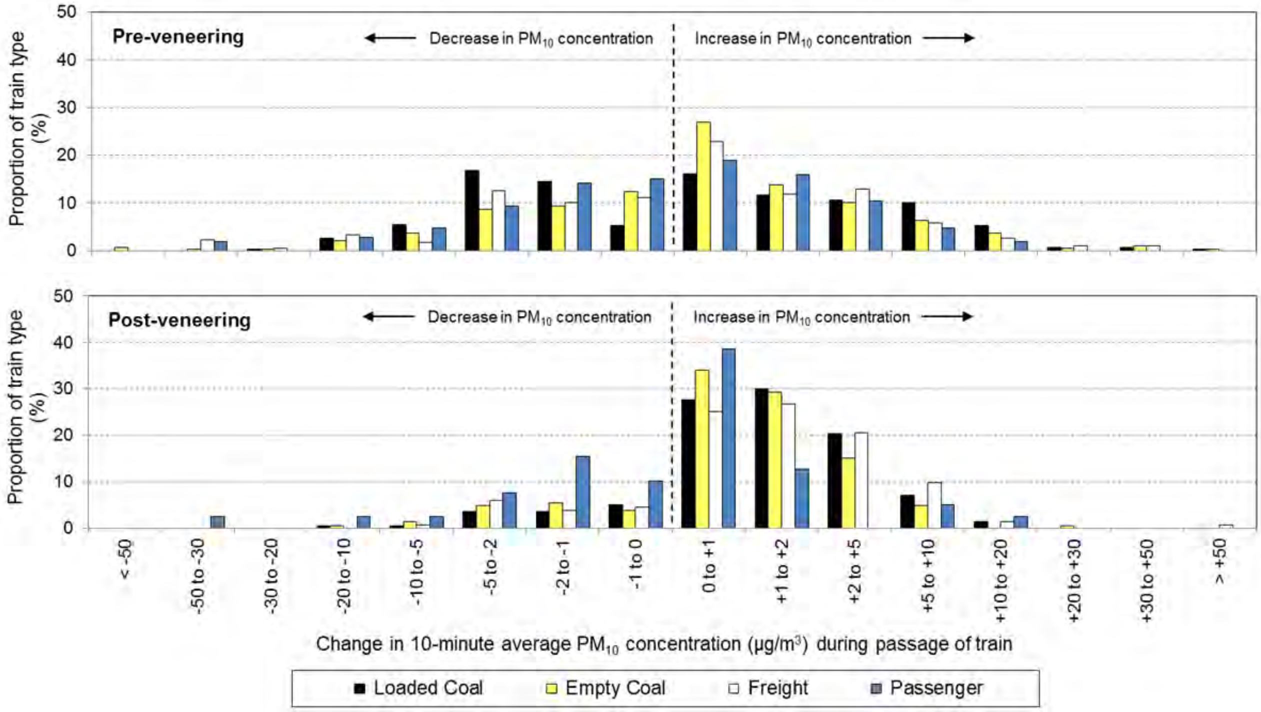

Figure 37: Comparison of the frequency of 10-minute average PM_{10} concentration changes during the passage of different train types at the Tennyson (North) monitoring site over the pre-veneering and post-veneering monitoring periods.

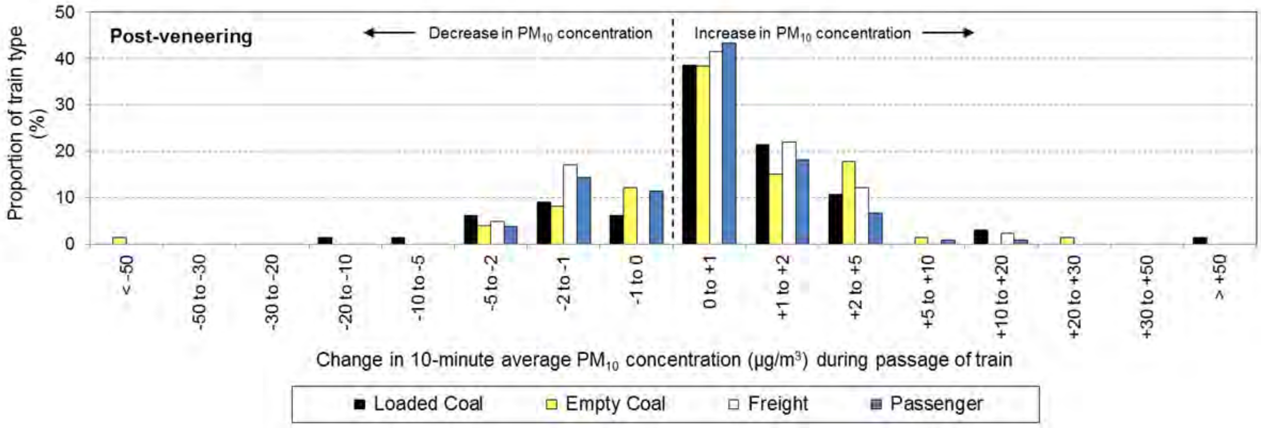

Figure 38: Frequency of 10-minute average PM_{10} concentration changes during the passage of different train types at the Fairfield (East) monitoring site over the post-veneering monitoring period.

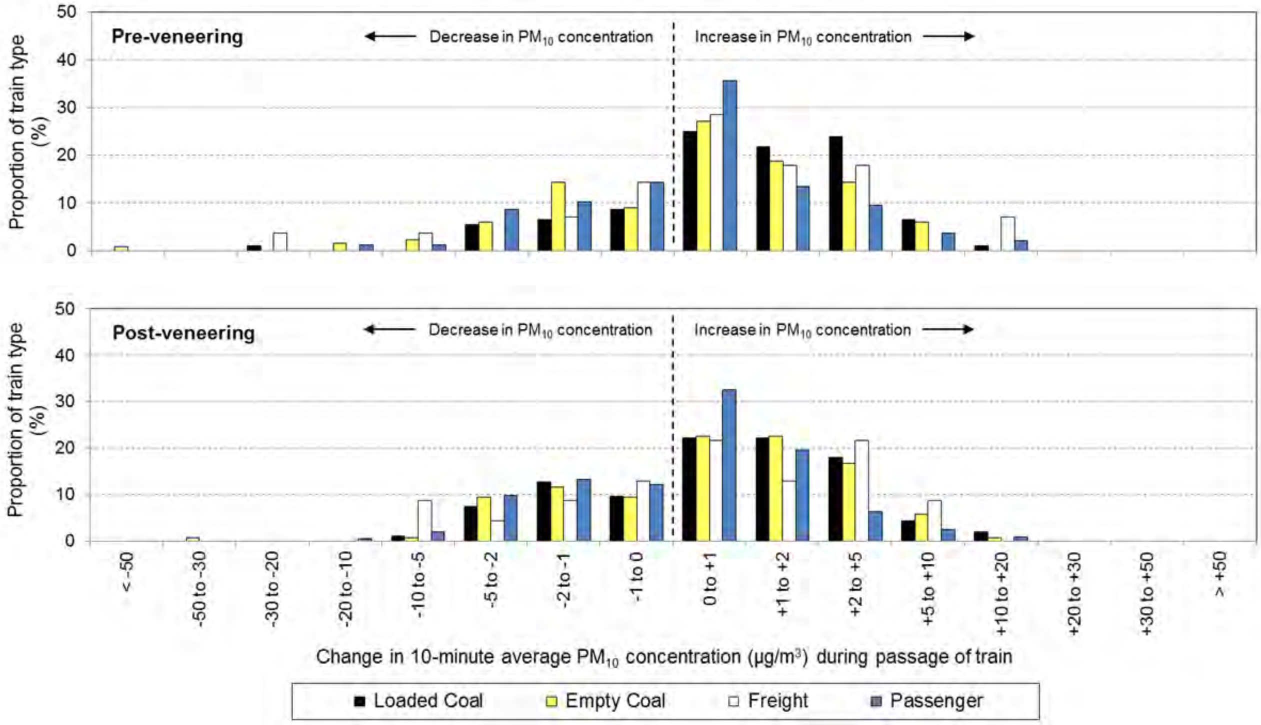

Figure 39: Comparison of the frequency of 10-minute average PM_{10} concentration changes during the passage of different train types at the Coorparoo (North) monitoring site over the pre-veneering and post-veneering periods.

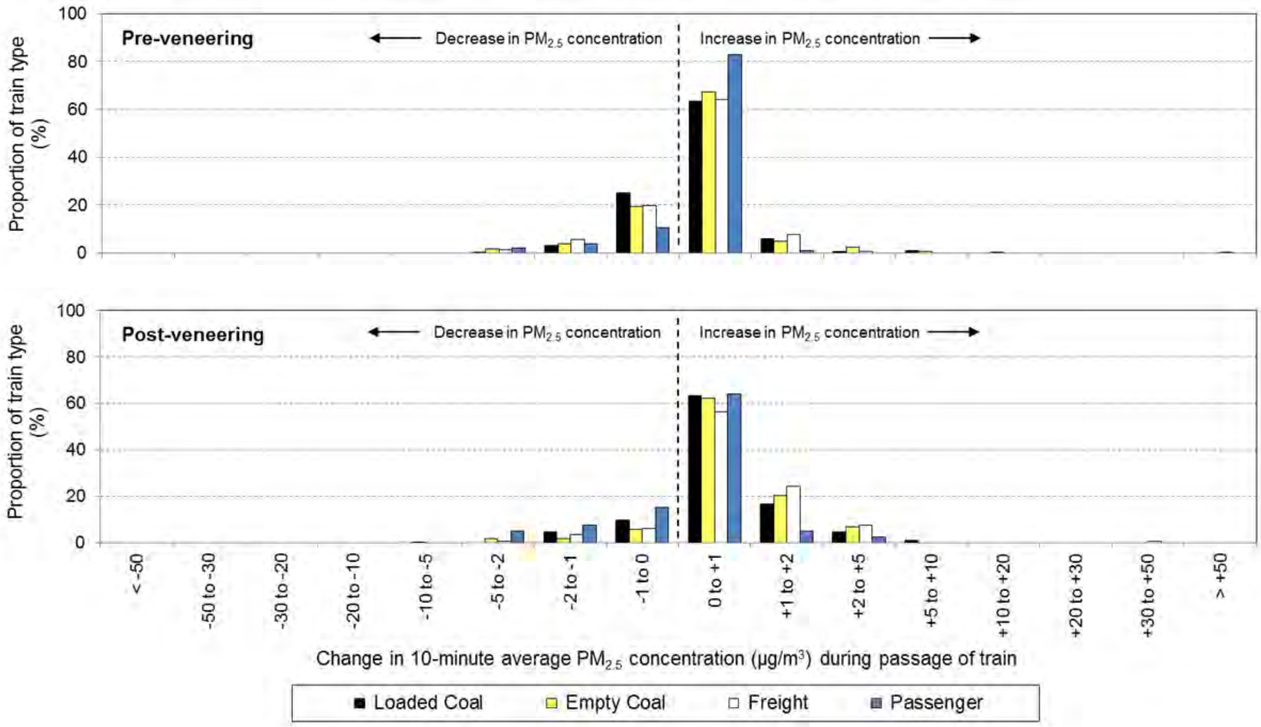

Figure 40: Comparison of the frequency of 10-minute average $PM_{2.5}$ concentration changes during the passage of different train types at the Tennyson (North) monitoring site over the pre-veneering and post-veneering monitoring periods.

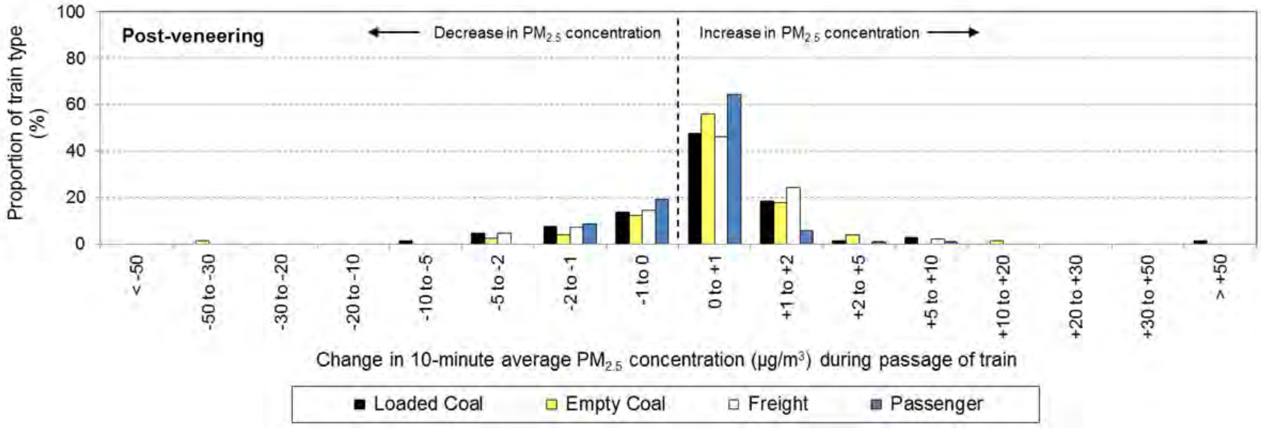

Figure 41: Frequency of 10-minute average $PM_{2.5}$ concentration changes during the passage of different train types at the Fairfield (East) monitoring site over the post-veneering monitoring period.

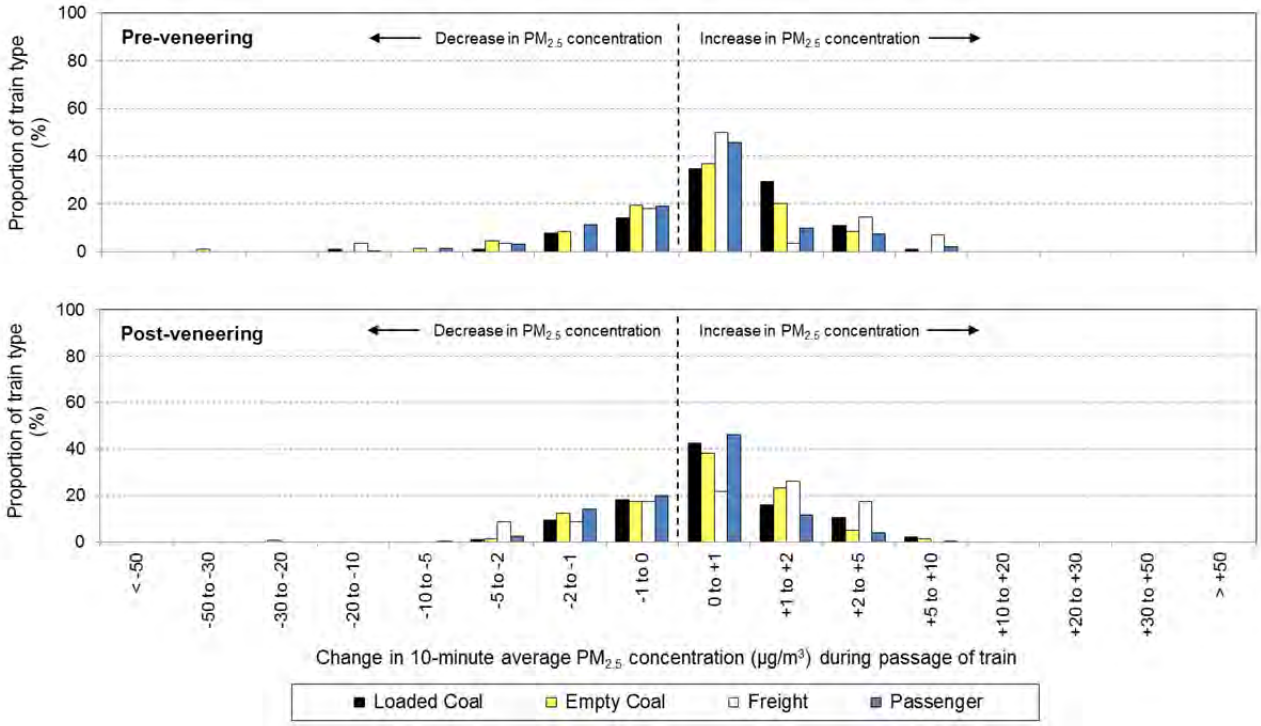

Figure 42: Comparison of the frequency of 10-minute average $PM_{2.5}$ concentration changes during the passage of different train types at the Coorparoo (North) monitoring site over the pre-veneering and post-veneering periods.

Overall, the passage of trains of all types was found to result in little change in ambient particle levels during the pre- and post-veneering monitoring periods. Most train movements were found to result in less than a 10 µg/m^3 change in PM_{10} levels and less than a 5 µg/m^3 change in $PM_{2.5}$ levels at the monitoring sites. There was no obvious change associated with the commencement of coal wagon veneering.

There was little overall difference seen in the short-term particle level changes associated with the different train types. From this it can be inferred that changes in particle levels resulting from the passage of trains are mainly the result of re-entrained particles from surfaces within the rail corridor rather than direct emissions from trains.

Conclusions

Analysis of the measurements at the monitoring sites located on the Western and Metropolitan rail system from March to June 2013 has found that ambient particle concentrations complied with ambient air quality objectives at all times during both the pre- and post-veneering monitoring periods.

Reduced dust emissions due to frequent rainfall in the months prior to and during the pre-veneering and post-veneering monitoring periods will have impacted on particle levels measured during the investigation period. This is reflected in lower PM_{10} and deposited dust measurements during this investigation compared with previous monitoring at the Tennyson (North) monitoring site during dry conditions in September and October 2012.

PM_{10} levels did not exceed the EPP Air 24-hour air quality objective of 50 µg/m^3 at any of the rail corridor monitoring sites during the pre- and post-veneering monitoring periods. The highest measured 24-hour PM_{10} concentration during the pre-veneering monitoring period was 32.2 µg/m^3, or 64 per cent of the EPP Air objective, at the urban background monitoring site at Chelmer. The highest 24-hour average PM_{10} concentration measured at one of the monitoring sites adjacent to the rail corridor used by coal trains was 28.5 µg/m^3 (57 per cent of the EPP Air objective) at the Fairfield (East) monitoring site. During the post-veneering monitoring period the highest measured 24-hour average PM_{10} concentration was 38.5 µg/m^3, or 77 per cent of the EPP Air objective, at the Fairfield (East) monitoring site.

$PM_{2.5}$ levels did not exceed the EPP Air 24-hour air quality objective of 25 µg/m^3 at any of the rail corridor monitoring sites during the pre- and post-veneering periods. In both periods, average $PM_{2.5}$ concentrations were less than the EPP Air annual objective value of 8 µg/m^3, although the periods of monitoring were insufficient to confirm compliance with this objective. The highest measured 24-hour average $PM_{2.5}$ concentration during the pre-veneering monitoring period was 23.2 µg/m^3 (93 per cent of the EPP Air objective) at the Coorparoo (North) site. The highest measured 24-hour average $PM_{2.5}$ concentration during the post-veneering monitoring period was 11.3 µg/m^3 (45 per cent of the EPP Air objective) at the Coorparoo (North) site.

A number of observations support the conclusion that the major influence on PM_{10} and $PM_{2.5}$ concentrations at the rail corridor monitoring sites is not rail transport emissions but regional urban particle emission sources. These include the close correspondence between PM_{10} and $PM_{2.5}$ levels measured at Metropolitan line rail corridor sites and DSITIA ambient air monitoring network sites elsewhere in Brisbane; the highest 24-hour $PM_{2.5}$ concentration during the pre-veneering period being recorded at the Chelmer background monitoring site; the lack of any strong relationship between PM_{10} and $PM_{2.5}$ levels and the proportion of winds from the direction of the rail corridor; PM_{10} and $PM_{2.5}$ measurements recorded on days when no coal and few freight train services were running differing little from the average concentrations over the monitoring period; and the results of statistical analyses which found that any impact from veneering was less than the day-to-day variability in PM_{10} and $PM_{2.5}$ concentrations.

Insoluble dust deposition rates did not exceed the trigger level for nuisance dust of 4 g/m^2/30days above background levels (or 130 mg/m^2/day averaged over the 30-day period) recommended by the New Zealand Ministry for the Environment at any of the rail corridor monitoring sites during both the pre- and post-veneering monitoring periods. The maximum insoluble dust deposition rate measured over the pre-veneering monitoring period was 114 mg/m^2/day at the Coorparoo (South) monitoring site. The maximum daily average insoluble dust deposition rate measured over the post-veneering period was 57 mg/m^2/day at the Tennyson (South) site.

Microscopic examination showed that mineral dust (soil or rock dust) was the major component (50 to 90 per cent) of the deposited dust at each monitoring site during both the pre- and post-veneering monitoring periods. Coal dust was consistently detected in the deposited dust from all monitoring sites along the rail corridor used by coal trains, but was only detected at trace levels in one sample at the Chelmer background monitoring site located on a section of the Metropolitan rail system not used by coal trains. Coal particles typically accounted for about 10 per cent of the total surface area in the deposited dust samples, with the amount present in individual samples ranging from trace levels up to 20 per cent of the total surface coverage. At most locations another black-coloured particle, rubber dust, was found to make up on average about 10 per cent of the deposited dust surface coverage.

A general trend towards decreased dust deposition rates and lower levels of coal dust in the deposited dust samples was observed at most monitoring sites following the implementation of rail wagon veneering at the New Hope Mine, although quantitative conclusions could not be drawn due to the presence of considerable amounts of plant and insect matter in many of the pre-veneering monitoring period samples. While this suggests that veneering has reduced the loss of coal particles during transit, monitoring over a period longer than one to two months is needed to demonstrate that this improvement is real and ongoing. This will be measured by the collection of deposited dust samples over a 12 month period at one rail corridor monitoring site within Brisbane as part of the second phase of the Western - Metropolitan Rail Systems Coal Dust Monitoring Program.

During both the pre- and post-veneering monitoring periods the passage of trains was found to result in little change in 10-minute average PM_{10} and $PM_{2.5}$ levels at the Tennyson, Fairfield and Coorparoo monitoring sites. There was also little overall difference seen between the short-term particle level changes associated with the passage of different train types. From this it can be inferred that changes in particle levels resulting from the passage of trains are mainly the result of re-entrained particles from surfaces within the rail corridor rather than direct emissions from trains.

Appendix 1: Measurement data

Table 10: 24-hour PM_{10} concentrations measured at the Oakey (North) monitoring site during the pre-veneering monitoring period, 7 March to 1 May 2013, together with daily wind frequency from the direction of the rail corridor and rainfall.

Sampling day	24-hour PM_{10} concentration ($\mu g/m^3$)	Proportion of winds from direction of rail corridor (%)	Rainfall[a] (mm)	Sampling day	24-hour PM_{10} concentration ($\mu g/m^3$)	Proportion of winds from direction of rail corridor (%)	Rainfall[a] (mm)
7/03/2013	9.9	0.0	0.6	4/04/2013	8.6	6.4	0.0
8/03/2013	8.9	0.0	1.0	5/04/2013	9.3	16.7	0.0
9/03/2013	7.6	4.2	0.0	6/04/2013	9.0	4.2	0.0
10/03/2013	14.5	18.8	0.2	7/04/2013	8.1	14.6	0.0
11/03/2013	12.0	12.5	0.0	8/04/2013	6.1	8.3	0.0
12/03/2013	16.0	22.9	0.0	9/04/2013	4.8	8.3	0.0
13/03/2013	15.2	45.8	0.0	10/04/2013	6.6	10.4	0.0
14/03/2013	12.9	52.1	0.0	11/04/2013	8.6	2.1	0.0
15/03/2013	14.2	6.3	0.0	12/04/2013	9.8	18.8	0.0
16/03/2013	21.8	31.3	0.0	13/04/2013	7.2	89.6	1.2
17/03/2013	21.9	56.3	0.2	14/04/2013	9.2	50.0	0.2
18/03/2013	19.2	0.0	0.0	15/04/2013	13.2	18.8	0.0
19/03/2013	10.5	0.0	0.0	16/04/2013	15.8	43.8	3.4
20/03/2013	9.8	0.0	0.0	17/04/2013	9.1	35.4	0.4
21/03/2013	12.0	0.0	0.0	18/04/2013	12.4	64.6	0.0
22/03/2013	8.5	0.0	0.0	19/04/2013	no data	60.4	0.0
23/03/2013	13.4	39.6	0.0	20/04/2013	no data	54.2	0.0
24/03/2013	14.3	14.6	21.6	21/04/2013	no data	8.3	0.0
25/03/2013	8.9	0.0	0.0	22/04/2013	no data	33.3	0.0
26/03/2013	9.0	2.1	0.0	23/04/2013	no data	75.0	0.0
27/03/2013	9.3	0.0	0.0	24/04/2013	no data	39.6	0.0
28/03/2013	11.6	2.1	0.0	25/04/2013	no data	47.9	0.0
29/03/2013	12.6	43.8	0.0	26/04/2013	no data	2.1	0.0
30/03/2013	11.4	0.0	0.2	27/04/2013	no data	14.6	0.0
31/03/2013	7.8	43.8	22.4	28/04/2013	no data	12.5	1.2
1/04/2013	9.9	81.3	0.0	29/04/2013	no data	4.2	0.0
2/04/2013	9.9	35.4	0.0	30/04/2013	no data	4.2	0.0
3/04/2013	10.8	18.8	1.4	1/05/2013	no data	10.4	0.0

[a] as recorded at the Bureau of Meteorology's Oakey Airport rainfall measurement site.

Note: missing data due to a filter exchange mechanism failure on the dichotomous Partisol® sampler that occurred between site visits.

Table 11: 24-hour PM_{10} concentrations measured at the Oakey (North) monitoring site during the post-veneering monitoring period, 2 May to 2 June 2013, together with daily wind frequency from the direction of the rail corridor and rainfall.

Sampling day	24-hour PM_{10} concentration ($\mu g/m^3$)	Proportion of winds from direction of rail corridor (%)	Rainfall[a] (mm)	Sampling day	24-hour PM_{10} concentration ($\mu g/m^3$)	Proportion of winds from direction of rail corridor (%)	Rainfall[a] (mm)
2/05/2013	23.4	27.1	0.0	17/05/2013	10.7	81.3	0.2
3/05/2013	13.3	4.2	0.8	18/05/2013	9.2	56.3	0.0
4/05/2013	20.1	56.3	0.0	19/05/2013	no data	85.4	0.0
5/05/2013	19.1	0.0	0.0	20/05/2013	no data	60.4	0.0
6/05/2013	18.4	0.0	0.0	21/05/2013	no data	39.6	0.0
7/05/2013	no data	0.0	0.0	22/05/2013	no data	16.7	0.6
8/05/2013	no data	4.2	0.0	23/05/2013	15.7	91.7	12.4
9/05/2013	no data	2.1	0.0	24/05/2013	9.4	91.7	0.0
10/05/2013	no data	8.3	0.0	25/05/2013	12.7	66.7	0.0
11/05/2013	no data	12.5	0.0	26/05/2013	16.2	44.7	0.0
12/05/2013	no data	6.3	0.4	27/05/2013	15.4	18.8	0.0
13/05/2013	no data	6.3	0.2	28/05/2013	9.2	8.3	0.0
14/05/2013	no data	75.0	12.0	29/05/2013	14.3	0.0	1.2
15/05/2013	no data	79.2	0.0	30/05/2013	5.2	0.0	0.0
16/05/2013	18.1	58.3	0.0	31/05/2013	10.2	0.0	0.2

[a] as recorded at the Bureau of Meteorology's Oakey Airport rainfall measurement site.

Note: missing data due to intermittent problems with filter exchange mechanism on the Partisol® sampler which occurred between site visits.

Table 12: 24-hour PM_{10} concentrations measured at the Dinmore (South) monitoring site during the pre-veneering monitoring period, 7 March to 1 May 2013, together with daily wind frequency from the direction of the rail corridor and rainfall.

Sampling day	24-hour PM_{10} concentration ($\mu g/m^3$)	Proportion of winds from direction of rail corridor (%)	Rainfall[a] (mm)	Sampling day	24-hour PM_{10} concentration ($\mu g/m^3$)	Proportion of winds from direction of rail corridor (%)	Rainfall[a] (mm)
7/03/2013	no data	8.3	0.0	4/04/2013	no data	10.4	1.8
8/03/2013	no data	12.5	0.2	5/04/2013	no data	0.0	0.7
9/03/2013	no data	4.2	1.1	6/04/2013	no data	4.2	0.0
10/03/2013	no data	27.1	0.0	7/04/2013	no data	22.9	1.5
11/03/2013	no data	8.3	1.1	8/04/2013	13.5	14.6	0.5
12/03/2013	no data	22.9	0.7	9/04/2013	15.2	50.0	2.5
13/03/2013	no data	27.1	0.0	10/04/2013	12.3	33.3	0.0
14/03/2013	no data	50.0	0.0	11/04/2013	14.8	27.1	0.1
15/03/2013	no data	33.3	0.0	12/04/2013	14.3	16.7	9.5
16/03/2013	no data	54.2	0.0	13/04/2013	8.1	35.4	18.6
17/03/2013	no data	64.6	0.0	14/04/2013	12.2	43.8	0.0
18/03/2013	no data	2.1	0.0	15/04/2013	17.1	66.7	0.0
19/03/2013	no data	31.3	0.0	16/04/2013	16	66.7	4.6
20/03/2013	no data	0.0	0.1	17/04/2013	12.9	47.9	4.6
21/03/2013	no data	52.1	0.0	18/04/2013	17.5	85.4	0.0
22/03/2013	no data	47.9	0.0	19/04/2013	25.8	70.8	0.0
23/03/2013	no data	56.3	0.0	20/04/2013	19.2	66.7	0.0
24/03/2013	no data	64.6	16.3	21/04/2013	11.3	60.4	0.0
25/03/2013	no data	25.0	0.0	22/04/2013	18.5	60.4	0.0
26/03/2013	no data	18.8	0.0	23/04/2013	no data	63.8	0.0
27/03/2013	no data	25.0	1.1	24/04/2013	14.6	18.8	0.0
28/03/2013	no data	39.6	0.0	25/04/2013	10.5	14.6	0.0
29/03/2013	no data	39.6	0.0	26/04/2013	11.9	20.8	0.0
30/03/2013	no data	16.7	0.0	27/04/2013	10.2	14.6	0.0
31/03/2013	no data	60.4	14.7	28/04/2013	7.4	18.8	0.0
1/04/2013	no data	60.4	0.1	29/04/2013	13	33.3	0.0
2/04/2013	no data	39.6	0.0	30/04/2013	12.6	22.9	0.0
3/04/2013	no data	54.2	0.0	1/05/2013	12.1	29.2	0.0

[a] as recorded at DSITIA's ambient air monitoring site at Rocklea.

Note: missing data prior to 8 April due to ongoing problems with filter exchange mechanism on the dichotomous Partisol® sampler. The dichotomous Partisol® sampler was replaced with a single channel PM_{10} Partisol® sampler on 7 April. A replacement dichotomous Partisol® sampler was reinstalled on 23 April in order to obtain both PM_{10} and $PM_{2.5}$ measurements at the monitoring site.

Table 13: 24-hour PM_{10} concentrations measured at the Dinmore (South) monitoring site during the post-veneering monitoring period, 2 May to 2 June 2013, together with daily wind frequency from the direction of the rail corridor and rainfall.

Sampling day	24-hour PM_{10} concentration ($\mu g/m^3$)	Proportion of winds from direction of rail corridor (%)	Rainfall[a] (mm)	Sampling day	24-hour PM_{10} concentration ($\mu g/m^3$)	Proportion of winds from direction of rail corridor (%)	Rainfall[a] (mm)
2/05/2013	12.2	0.0	0.0	18/05/2013	13.0	2.1	0.0
3/05/2013	24.2	2.1	0.0	19/05/2013	7.3	0.0	0.0
4/05/2013	23.7	14.6	0.0	20/05/2013	11.1	6.3	0.0
5/05/2013	23.7	12.5	0.0	21/05/2013	19.0	4.2	0.0
6/05/2013	22.3	12.5	0.0	22/05/2013	14.7	10.4	4.5
7/05/2013	12.7	4.2	0.0	23/05/2013	8.4	0.0	0.0
8/05/2013	14.1	8.3	0.0	24/05/2013	12.6	0.0	0.7
9/05/2013	12.4	0.0	1.0	25/05/2013	30.7	0.0	0.0
10/05/2013	15.2	6.3	1.0	26/05/2013	11.5	0.0	0.0
11/05/2013	12.5	2.1	4.5	27/05/2013	no data	2.1	0.0
12/05/2013	7.9	10.4	3.5	28/05/2013	19.6	0.0	5.0
13/05/2013	9.7	14.6	1.5	29/05/2013	17.3	4.2	2.2
14/05/2013	11.0	2.1	1.2	30/05/2013	17.2	16.7	22.9
15/05/2013	10.1	16.7	0.0	31/05/2013	9.7	2.1	1.1
16/05/2013	9.2	0.0	0.0	1/06/2013	18.7	31.3	0.0
17/05/2013	no data	0.0	0.0				

[a] as recorded at DSITIA's ambient air monitoring site at Rocklea.

Note: missing data due to intermittent problems with filter exchange mechanism on the Partisol® sampler which occurred between site visits.

Table 14: 24-hour PM_{10} concentrations measured at the Fairfield (East) monitoring site during the pre-veneering monitoring period, 6 March to 1 May 2013, together with daily wind frequency from the direction of the rail corridor and rainfall.

Sampling day	24-hour PM_{10} concentration (μg/m^3)	Proportion of winds from direction of rail corridor (%)	Rainfall[a] (mm)
6/03/2013	13.2	8.3	0.8
7/03/2013	no data	14.6	0.0
8/03/2013	no data	18.8	0.2
9/03/2013	no data	14.6	1.1
10/03/2013	no data	35.4	0.0
11/03/2013	no data	22.9	1.1
12/03/2013	no data	33.3	0.7
13/03/2013	18.7	47.9	0.0
14/03/2013	16.3	52.1	0.0
15/03/2013	21.6	43.8	0.0
16/03/2013	no data	52.1	0.0
17/03/2013	no data	54.2	0.0
18/03/2013	no data	20.8	0.0
19/03/2013	no data	22.9	0.0
20/03/2013	no data	18.8	0.1
21/03/2013	16.7	39.6	0.0
22/03/2013	15.3	52.1	0.0
23/03/2013	13.3	47.9	0.0
24/03/2013	13	58.3	16.3
25/03/2013	11.1	25.0	0.0
26/03/2013	11.3	6.3	0.0
27/03/2013	14.9	29.2	1.1
28/03/2013	28.5	25.0	0.0
29/03/2013	14.5	47.9	0.0
30/03/2013	20.8	0.0	0.0
31/03/2013	13.9	70.5	14.7
1/04/2013	no data	42.9	0.1
2/04/2013	no data	20.8	0.0
3/04/2013	15	35.4	0.0
4/04/2013	11.2	18.8	1.8
5/04/2013	13.6	31.3	0.7
6/04/2013	12.4	50.0	0.0
7/04/2013	9.6	43.8	1.5
8/04/2013	10.5	35.4	0.5
9/04/2013	9.9	37.5	2.5
10/04/2013	11.4	35.4	0.0
11/04/2013	12.2	27.1	0.1
12/04/2013	14.7	56.3	9.5
13/04/2013	9.1	64.6	18.6
14/04/2013	14.2	56.3	0.0
15/04/2013	20.3	52.1	0.0
16/04/2013	18.1	56.3	4.6
17/04/2013	14	50.0	4.6
18/04/2013	16.1	70.8	0.0
19/04/2013	24	58.3	0.0
20/04/2013	20.3	85.4	0.0
21/04/2013	10.8	35.4	0.0
22/04/2013	17.4	37.5	0.0
23/04/2013	15.2	56.3	0.0
24/04/2013	25.3	43.8	0.0
25/04/2013	19.8	64.6	0.0
26/04/2013	19	43.8	0.0
27/04/2013	17.5	45.8	0.0
28/04/2013	15	58.3	0.0
29/04/2013	17.8	52.1	0.0
30/04/2013	17.6	43.8	0.0
1/05/2013	21.2	56.3	0.0

[a] as recorded at DSITIA's ambient air monitoring site at Rocklea.

Note: missing data due to intermittent problems with filter exchange mechanism on the Partisol® sampler which occurred between site visits.

Table 15: 24-hour PM_{10} concentrations measured at the Fairfield (East) monitoring site during the post-veneering monitoring period, 2 May to 2 July 2013, together with daily wind frequency from the direction of the rail corridor and rainfall.

Sampling day	24-hour PM_{10} concentration ($\mu g/m^3$)	Proportion of winds from direction of rail corridor (%)	Rainfall[a] (mm)
2/05/2013	19.8	35.4	0.0
3/05/2013	38.5	25.0	0.0
4/05/2013	23.1	70.8	0.0
5/05/2013	16.8	35.4	0.0
6/05/2013	11.8	27.1	0.0
7/05/2013	9.3	41.7	0.0
8/05/2013	10.7	33.3	0.0
9/05/2013	15.0	43.8	1.0
10/05/2013	13.4	50.0	1.0
11/05/2013	9.0	50.0	4.5
12/05/2013	10.8	58.3	3.5
13/05/2013	10.5	56.3	1.5
14/05/2013	7.5	89.6	1.2
15/05/2013	10.9	60.4	0.0
16/05/2013	no data	54.2	0.0
17/05/2013	16.1	72.9	0.0
18/05/2013	no data	52.1	0.0
19/05/2013	no data	62.5	0.0
20/05/2013	no data	58.3	0.0
21/05/2013	18.7	79.2	0.0
22/05/2013	17.5	81.3	4.5
23/05/2013	7.3	62.5	0.0
24/05/2013	6.5	85.4	0.7
25/05/2013	9.4	60.4	0.0
26/05/2013	12.5	58.3	0.0
27/05/2013	16.2	58.3	0.0
28/05/2013	14.0	44.7	5.0
29/05/2013	14.2	37.5	2.2
30/05/2013	12.1	41.7	22.9
31/05/2013	15.7	29.2	1.1
1/06/2013	18.1	54.2	0.0
2/06/2013	12.4	72.9	0.7
3/06/2013	11.7	50.0	0.0
4/06/2013	19.5	70.8	0.0
5/06/2013	21.9	68.8	0.0
6/06/2013	22.1	45.8	0.2
7/06/2013	23.0	66.7	0.0
8/06/2013	17.7	68.8	7.3
9/06/2013	12.3	29.2	3.9
10/06/2013	7.0	81.3	31.1
11/06/2013	11.5	54.2	0.7
12/06/2013	11.4	68.8	7.3
13/06/2013	10.9	58.3	0.0
14/06/2013	11.5	95.8	0.0
15/06/2013	no data	93.8	0.0
16/06/2013	10.1	60.4	0.0
17/06/2013	13.5	68.8	0.0
18/06/2013	13.9	66.7	0.0
19/06/2013	12.2	50.0	0.0
20/06/2013	3.8	70.8	2.7
21/06/2013	24.0	77.1	6.2
22/06/2013	5.7	66.7	0.0
23/06/2013	7.5	58.3	0.0
24/06/2013	10.4	52.1	0.0
25/06/2013	no data	81.3	0.0
26/06/2013	no data	60.4	0.0
27/06/2013	9.9	66.7	1.1
28/06/2013	13.6	64.6	2.7
29/06/2013	10.5	58.3	2.6
30/06/2013	6.1	85.4	9.5
1/07/2013	5.2	97.9	19.9

[a] as recorded at DSITIA's ambient air monitoring site at Rocklea.

Note: missing data due to intermittent problems with filter exchange mechanism on the Partisol® sampler which occurred between site visits.

Table 16: 24-hour PM_{10} concentrations measured at the Coorparoo (North) monitoring site during the pre-veneering monitoring period, 5 March to 1 May 2013, together with daily wind frequency from the direction of the rail corridor and rainfall.

Sampling day	24-hour PM_{10} concentration ($\mu g/m^3$)	Proportion of winds from direction of rail corridor (%)	Rainfall[a] (mm)	Sampling day	24-hour PM_{10} concentration ($\mu g/m^3$)	Proportion of winds from direction of rail corridor (%)	Rainfall[a] (mm)
5/03/2013	15.2	91.7	1.2	3/04/2013	15.8	60.4	0.0
6/03/2013	12.2	91.7	0.8	4/04/2013	10.7	77.1	1.8
7/03/2013	13.3	85.4	0.0	5/04/2013	13.4	83.3	0.7
8/03/2013	12.8	81.3	0.2	6/04/2013	10.6	58.3	0.0
9/03/2013	10.7	85.4	1.1	7/04/2013	7.8	43.8	1.5
10/03/2013	15.2	64.6	0.0	8/04/2013	9.4	60.4	0.5
11/03/2013	19.6	77.1	1.1	9/04/2013	8.9	60.4	2.5
12/03/2013	23.5	66.7	0.7	10/04/2013	10.3	64.6	0.0
13/03/2013	18.4	54.2	0.0	11/04/2013	13.3	75.0	0.1
14/03/2013	16.8	47.9	0.0	12/04/2013	13.1	79.2	9.5
15/03/2013	21.4	58.3	0.0	13/04/2013	6.6	45.8	18.6
16/03/2013	22.1	41.7	0.0	14/04/2013	12.8	39.6	0.0
17/03/2013	no data	45.8	0.0	15/04/2013	19.9	50.0	0.0
18/03/2013	no data	75.0	0.0	16/04/2013	18.8	39.6	4.6
19/03/2013	no data	72.9	0.0	17/04/2013	14.4	50.0	4.6
20/03/2013	no data	91.7	0.1	18/04/2013	16.4	22.9	0.0
21/03/2013	17.4	52.1	0.0	19/04/2013	24.6	33.3	0.0
22/03/2013	no data	54.2	0.0	20/04/2013	18.0	12.5	0.0
23/03/2013	13.3	31.3	0.0	21/04/2013	11.3	56.3	0.0
24/03/2013	12.5	31.3	16.3	22/04/2013	19.2	54.2	0.0
25/03/2013	11.9	72.9	0.0	23/04/2013	26.5	37.5	0.0
26/03/2013	11.8	81.3	0.0	24/04/2013	24.0	56.3	0.0
27/03/2013	14.8	70.8	1.1	25/04/2013	19.2	37.5	0.0
28/03/2013	15.6	72.9	0.0	26/04/2013	18.6	52.1	0.0
29/03/2013	13.2	54.2	0.0	27/04/2013	15.3	45.8	0.0
30/03/2013	17.1	100.0	0.0	28/04/2013	14.5	43.8	0.0
31/03/2013	12.6	28.6	14.7	29/04/2013	17.9	41.7	0.0
1/04/2013	12.3	45.8	0.1	30/04/2013	18.1	43.8	0.0
2/04/2013	13.1	62.5	0.0	1/05/2013	19.8	47.9	0.0

[a] as recorded at DSITIA's ambient air monitoring site at Rocklea.

Note: missing data due to intermittent problems with filter exchange mechanism on the Partisol® sampler which occurred between site visits.

Table 17: 24-hour PM_{10} concentrations measured at the Coorparoo (North) monitoring site during the post-veneering monitoring period, 2 May to 2 July 2013, together with daily wind frequency from the direction of the rail corridor and rainfall.

Sampling day	24-hour PM_{10} concentration ($\mu g/m^3$)	Proportion of winds from direction of rail corridor (%)	Rainfall[a] (mm)	Sampling day	24-hour PM_{10} concentration ($\mu g/m^3$)	Proportion of winds from direction of rail corridor (%)	Rainfall[a] (mm)
2/05/2013	19.8	68.8	0.0	2/06/2013	no data	25.0	0.7
3/05/2013	22.6	60.4	0.0	3/06/2013	no data	33.3	0.0
4/05/2013	19.8	22.9	0.0	4/06/2013	no data	31.3	0.0
5/05/2013	24.4	56.3	0.0	5/06/2013	21.9	14.6	0.0
6/05/2013	17.0	64.6	0.0	6/06/2013	no data	52.1	0.2
7/05/2013	10.7	60.4	0.0	7/06/2013	29.6	37.5	0.0
8/05/2013	9.0	68.8	0.0	8/06/2013	15.3	41.7	7.3
9/05/2013	10.4	62.5	1.0	9/06/2013	11.3	93.8	3.9
10/05/2013	11.6	45.8	1.0	10/06/2013	8.0	22.9	31.1
11/05/2013	11.9	41.7	4.5	11/06/2013	10.2	47.9	0.7
12/05/2013	8.0	35.4	3.5	12/06/2013	11.4	16.7	7.3
13/05/2013	10.6	31.3	1.5	13/06/2013	10.7	22.9	0.0
14/05/2013	8.6	12.5	1.2	14/06/2013	no data	2.1	0.0
15/05/2013	10.0	29.2	0.0	15/06/2013	5.0	8.3	0.0
16/05/2013	no data	25.0	0.0	16/06/2013	10.7	22.9	0.0
17/05/2013	no data	22.9	0.0	17/06/2013	no data	16.7	0.0
18/05/2013	8.3	25.0	0.0	18/06/2013	no data	8.3	0.0
19/05/2013	8.2	14.6	0.0	19/06/2013	no data	14.6	0.0
20/05/2013	16.4	27.1	0.0	20/06/2013	no data	18.8	2.7
21/05/2013	18.0	18.8	0.0	21/06/2013	no data	16.7	6.2
22/05/2013	12.2	4.2	4.5	22/06/2013	no data	29.2	0.0
23/05/2013	6.6	27.1	0.0	23/06/2013	no data	20.8	0.0
24/05/2013	no data	4.2	0.7	24/06/2013	no data	14.6	0.0
25/05/2013	no data	12.5	0.0	25/06/2013	no data	20.8	0.0
26/05/2013	no data	43.8	0.0	26/06/2013	10.1	22.9	0.0
27/05/2013	17.2	43.8	0.0	27/06/2013	14.1	27.1	1.1
28/05/2013	14.0	47.9	5.0	28/06/2013	9.8	47.9	2.7
29/05/2013	14.4	66.7	2.2	29/06/2013	9.1	45.8	2.6
30/05/2013	11.0	27.1	22.9	30/06/2013	6.0	10.4	9.5
31/05/2013	15.5	50.0	1.1	1/07/2013	5.0	2.1	19.9
1/06/2013	18.0	37.5	0.0	2/07/2013	5.4	2.2	0.0

[a] as recorded at DSITIA's ambient air monitoring site at Rocklea.

Note: missing data due to intermittent problems with filter exchange mechanism on the Partisol® sampler which occurred between site visits.

Table 18: 24-hour PM_{10} concentrations measured at the Chelmer background monitoring site during the pre-veneering monitoring period, 5 March to 1 May 2013, together with daily wind frequency from the direction of the rail corridor and rainfall.

Sampling day	24-hour PM_{10} concentration ($\mu g/m^3$)	Proportion of winds from direction of rail corridor (%)	Rainfall[a] (mm)
5/03/2013	15.3	16.7	1.2
6/03/2013	11.4	25.0	0.8
7/03/2013	13.4	33.3	0.0
8/03/2013	11.4	31.3	0.2
9/03/2013	9.8	33.3	1.1
10/03/2013	13.0	41.7	0.0
11/03/2013	17.6	43.8	1.1
12/03/2013	32.2	50.0	0.7
13/03/2013	17.3	54.2	0.0
14/03/2013	15	62.5	0.0
15/03/2013	18.3	64.6	0.0
16/03/2013	18.3	56.3	0.0
17/03/2013	no data	56.3	0.0
18/03/2013	no data	25.0	0.0
19/03/2013	no data	35.4	0.0
20/03/2013	14.1	22.9	0.1
21/03/2013	15.0	56.3	0.0
22/03/2013	17.0	50.0	0.0
23/03/2013	9.5	43.8	0.0
24/03/2013	11.8	31.3	16.3
25/03/2013	12.9	37.5	0.0
26/03/2013	no data	37.5	0.0
27/03/2013	no data	43.8	1.1
28/03/2013	no data	56.3	0.0
29/03/2013	no data	50.0	0.0
30/03/2013	no data	22.9	0.0
31/03/2013	no data	70.8	14.7
1/04/2013	no data	64.6	0.1
2/04/2013	no data	70.8	0.0
3/04/2013	no data	64.6	0.0
4/04/2013	25.8	54.2	1.8
5/04/2013	13.5	47.9	0.7
6/04/2013	10.9	60.4	0.0
7/04/2013	no data	58.3	1.5
8/04/2013	11.5	58.3	0.5
9/04/2013	10.7	52.1	2.5
10/04/2013	10.2	47.9	0.0
11/04/2013	14.1	37.5	0.1
12/04/2013	15.5	62.5	9.5
13/04/2013	no data	85.4	18.6
14/04/2013	no data	75.0	0.0
15/04/2013	no data	52.1	0.0
16/04/2013	13.0	77.1	4.6
17/04/2013	13.9	50.0	4.6
18/04/2013	14.2	93.8	0.0
19/04/2013	21.5	91.7	0.0
20/04/2013	21.9	85.4	0.0
21/04/2013	10.5	60.4	0.0
22/04/2013	14.8	54.2	0.0
23/04/2013	no data	72.9	0.0
24/04/2013	18.9	25.0	0.0
25/04/2013	13.9	43.8	0.0
26/04/2013	19.6	0.0	0.0
27/04/2013	10.8	0.0	0.0
28/04/2013	9.8	4.2	0.0
29/04/2013	10.7	0.0	0.0
30/04/2013	11.4	4.2	0.0
1/05/2013	12.7	6.3	0.0

[a] as recorded at DSITIA's ambient air monitoring site at Rocklea.

Note: missing data due to intermittent problems with filter exchange mechanism on the Partisol® sampler which occurred between site visits.

Table 19: 24-hour PM_{10} concentrations measured at the Chelmer background monitoring site during the post-veneering monitoring period, 2 May to 2 June 2013, together with daily wind frequency from the direction of the rail corridor and rainfall.

Sampling day	24-hour PM_{10} concentration ($\mu g/m^3$)	Proportion of winds from direction of rail corridor (%)	Rainfall[a] (mm)
2/05/2013	15.3	25.0	0.0
3/05/2013	19.0	79.2	0.0
4/05/2013	15.7	95.8	0.0
5/05/2013	19.4	54.2	0.0
6/05/2013	15.7	47.9	0.0
7/05/2013	9.0	45.8	0.0
8/05/2013	8.3	41.7	0.0
9/05/2013	8.9	52.1	1.0
10/05/2013	11.6	66.7	1.0
11/05/2013	11.2	72.9	4.5
12/05/2013	6.9	81.3	3.5
13/05/2013	11.1	83.3	1.5
14/05/2013	8.2	100.0	1.2
15/05/2013	7.6	89.6	0.0
16/05/2013	no data	75.0	0.0
17/05/2013	8.7	89.6	0.0
18/05/2013	10.4	97.9	0.0
19/05/2013	9.2	93.8	0.0
20/05/2013	11.2	91.7	0.0
21/05/2013	13.5	91.7	0.0
22/05/2013	11.9	83.3	4.5
23/05/2013	6.2	79.2	0.0
24/05/2013	4.1	100.0	0.7
25/05/2013	19.1	89.6	0.0
26/05/2013	26.7	83.3	0.0
27/05/2013	24.2	79.2	0.0
28/05/2013	12.6	66.7	5.0
29/05/2013	11.4	50.0	2.2
30/05/2013	9.0	77.1	22.9
31/05/2013	12.7	62.5	1.1
1/06/2013	15.3	66.7	0.0
2/06/2013	8.5	91.7	0.7

[a] as recorded at DSITIA's ambient air monitoring site at Rocklea.

Note: missing data due to intermittent problems with filter exchange mechanism on the Partisol® sampler which occurred between site visits.

Table 20: 24-hour $PM_{2.5}$ concentrations measured at the Oakey (North) monitoring site during the pre-veneering monitoring period, 7 March to 1 May 2013, together with daily wind frequency from the direction of the rail corridor and rainfall.

Sampling day	24-hour $PM_{2.5}$ concentration ($\mu g/m^3$)	Proportion of winds from direction of rail corridor (%)	Rainfall[a] (mm)
7/03/2013	2.9	0.0	0.6
8/03/2013	2.5	0.0	1.0
9/03/2013	1.8	4.2	0.0
10/03/2013	4	18.8	0.2
11/03/2013	3.8	12.5	0.0
12/03/2013	4.4	22.9	0.0
13/03/2013	4.5	45.8	0.0
14/03/2013	4.2	52.1	0.0
15/03/2013	5.2	6.3	0.0
16/03/2013	8.2	31.3	0.0
17/03/2013	5.8	56.3	0.2
18/03/2013	5.2	0.0	0.0
19/03/2013	3.2	0.0	0.0
20/03/2013	2.7	0.0	0.0
21/03/2013	4.1	0.0	0.0
22/03/2013	2.8	0.0	0.0
23/03/2013	3.5	39.6	0.0
24/03/2013	4.2	14.6	21.6
25/03/2013	3.4	0.0	0.0
26/03/2013	3.9	2.1	0.0
27/03/2013	3.4	0.0	0.0
28/03/2013	3.4	2.1	0.0
29/03/2013	4	43.8	0.0
30/03/2013	4.5	0.0	0.2
31/03/2013	2.7	43.8	22.4
1/04/2013	4.4	81.3	0.0
2/04/2013	4.9	35.4	0.0
3/04/2013	4.6	18.8	1.4

Sampling day	24-hour $PM_{2.5}$ concentration ($\mu g/m^3$)	Proportion of winds from direction of rail corridor (%)	Rainfall[a] (mm)
4/04/2013	3.2	6.4	0.0
5/04/2013	2.5	16.7	0.0
6/04/2013	2.4	4.2	0.0
7/04/2013	2.1	14.6	0.0
8/04/2013	2.1	8.3	0.0
9/04/2013	1.8	8.3	0.0
10/04/2013	1.6	10.4	0.0
11/04/2013	2.5	2.1	0.0
12/04/2013	2.8	18.8	0.0
13/04/2013	2.6	89.6	1.2
14/04/2013	4.3	50.0	0.2
15/04/2013	4.9	18.8	0.0
16/04/2013	4.6	43.8	3.4
17/04/2013	3.1	35.4	0.4
18/04/2013	4.2	64.6	0.0
19/04/2013	no data	60.4	0.0
20/04/2013	no data	54.2	0.0
21/04/2013	no data	8.3	0.0
22/04/2013	no data	33.3	0.0
23/04/2013	no data	75.0	0.0
24/04/2013	no data	39.6	0.0
25/04/2013	no data	47.9	0.0
26/04/2013	no data	2.1	0.0
27/04/2013	no data	14.6	0.0
28/04/2013	no data	12.5	1.2
29/04/2013	no data	4.2	0.0
30/04/2013	no data	4.2	0.0
1/05/2013	no data	10.4	0.0

[a] as recorded at the Bureau of Meteorology's Oakey Airport rainfall measurement site.

Note: missing data due to a filter exchange mechanism failure on the dichotomous Partisol® sampler that occurred between site visits.

Table 21: 24-hour $PM_{2.5}$ concentrations measured at the Oakey (North) monitoring site during the post-veneering monitoring period, 2 May to 2 June 2013, together with daily wind frequency from the direction of the rail corridor and rainfall.

Sampling day	24-hour $PM_{2.5}$ concentration ($\mu g/m^3$)	Proportion of winds from direction of rail corridor (%)	Rainfall[a] (mm)	Sampling day	24-hour $PM_{2.5}$ concentration ($\mu g/m^3$)	Proportion of winds from direction of rail corridor (%)	Rainfall[a] (mm)
2/05/2013	7.9	27.1	0.0	17/05/2013	3.4	81.3	0.2
3/05/2013	5.7	4.2	0.8	18/05/2013	3.8	56.3	0.0
4/05/2013	8.2	56.3	0.0	19/05/2013	no data	85.4	0.0
5/05/2013	9.1	0.0	0.0	20/05/2013	no data	60.4	0.0
6/05/2013	7.2	0.0	0.0	21/05/2013	no data	39.6	0.0
7/05/2013	no data	0.0	0.0	22/05/2013	no data	16.7	0.6
8/05/2013	no data	4.2	0.0	23/05/2013	6.5	91.7	12.4
9/05/2013	no data	2.1	0.0	24/05/2013	2.9	91.7	0.0
10/05/2013	no data	8.3	0.0	25/05/2013	4.8	66.7	0.0
11/05/2013	no data	12.5	0.0	26/05/2013	5.8	44.7	0.0
12/05/2013	no data	6.3	0.4	27/05/2013	5.9	18.8	0.0
13/05/2013	no data	6.3	0.2	28/05/2013	4.2	8.3	0.0
14/05/2013	no data	75.0	12.0	29/05/2013	3.9	0.0	1.2
15/05/2013	no data	79.2	0.0	30/05/2013	2.2	0.0	0.0
16/05/2013	6.6	58.3	0.0	31/05/2013	3.7	0.0	0.2

[a] as recorded at the Bureau of Meteorology's Oakey Airport rainfall measurement site.

Note: missing data due to intermittent problems with filter exchange mechanism on the Partisol® sampler which occurred between site visits.

Table 22: 24-hour $PM_{2.5}$ concentrations measured at the Dinmore (South) monitoring site during the pre-veneering monitoring period, 7 March to 1 May 2013, together with daily wind frequency from the direction of the rail corridor and rainfall.

Sampling day	24-hour $PM_{2.5}$ concentration ($\mu g/m^3$)	Proportion of winds from direction of rail corridor (%)	Rainfall[a] (mm)	Sampling day	24-hour $PM_{2.5}$ concentration ($\mu g/m^3$)	Proportion of winds from direction of rail corridor (%)	Rainfall[a] (mm)
7/03/2013	no data	8.3	0.0	4/04/2013	no data	10.4	1.8
8/03/2013	no data	12.5	0.2	5/04/2013	no data	0.0	0.7
9/03/2013	no data	4.2	1.1	6/04/2013	no data	4.2	0.0
10/03/2013	no data	27.1	0.0	7/04/2013	no data	22.9	1.5
11/03/2013	no data	8.3	1.1	8/04/2013	no data	14.6	0.5
12/03/2013	no data	22.9	0.7	9/04/2013	no data	50.0	2.5
13/03/2013	no data	27.1	0.0	10/04/2013	no data	33.3	0.0
14/03/2013	no data	50.0	0.0	11/04/2013	no data	27.1	0.1
15/03/2013	no data	33.3	0.0	12/04/2013	no data	16.7	9.5
16/03/2013	no data	54.2	0.0	13/04/2013	no data	35.4	18.6
17/03/2013	no data	64.6	0.0	14/04/2013	no data	43.8	0.0
18/03/2013	no data	2.1	0.0	15/04/2013	no data	66.7	0.0
19/03/2013	no data	31.3	0.0	16/04/2013	no data	66.7	4.6
20/03/2013	no data	0.0	0.1	17/04/2013	no data	47.9	4.6
21/03/2013	no data	52.1	0.0	18/04/2013	no data	85.4	0.0
22/03/2013	no data	47.9	0.0	19/04/2013	no data	70.8	0.0
23/03/2013	no data	56.3	0.0	20/04/2013	no data	66.7	0.0
24/03/2013	no data	64.6	16.3	21/04/2013	no data	60.4	0.0
25/03/2013	no data	25.0	0.0	22/04/2013	no data	60.4	0.0
26/03/2013	no data	18.8	0.0	23/04/2013	no data	63.8	0.0
27/03/2013	no data	25.0	1.1	24/04/2013	7.9	18.8	0.0
28/03/2013	no data	39.6	0.0	25/04/2013	4.4	14.6	0.0
29/03/2013	no data	39.6	0.0	26/04/2013	5.7	20.8	0.0
30/03/2013	no data	16.7	0.0	27/04/2013	4.2	14.6	0.0
31/03/2013	no data	60.4	14.7	28/04/2013	3.5	18.8	0.0
1/04/2013	no data	60.4	0.1	29/04/2013	6.2	33.3	0.0
2/04/2013	no data	39.6	0.0	30/04/2013	5.2	22.9	0.0
3/04/2013	no data	54.2	0.0	1/05/2013	5.0	29.2	0.0

[a] as recorded at DSITIA's ambient air monitoring site at Rocklea.

Note: missing data prior to 23 April was due to ongoing problems with filter exchange mechanism on the dichotomous Partisol® sampler, which was removed on 7 April. At the time DSITIA did not have a spare dichotomous Partisol® sampler and a single channel Partisol® sample measuring PM_{10} only was installed. A replacement dichotomous Partisol® sampler was installed on 23 April.

Table 23: 24-hour $PM_{2.5}$ concentrations measured at the Dinmore (South) monitoring site during the post-veneering monitoring period, 2 May to 2 June 2013, together with daily wind frequency from the direction of the rail corridor and rainfall.

Sampling day	24-hour $PM_{2.5}$ concentration ($\mu g/m^3$)	Proportion of winds from direction of rail corridor (%)	Rainfall[a] (mm)
2/05/2013	5.8	0.0	0.0
3/05/2013	6.9	2.1	0.0
4/05/2013	8.7	14.6	0.0
5/05/2013	10.1	12.5	0.0
6/05/2013	7.2	12.5	0.0
7/05/2013	4	4.2	0.0
8/05/2013	4.3	8.3	0.0
9/05/2013	4.3	0.0	1.0
10/05/2013	6	6.3	1.0
11/05/2013	5.1	2.1	4.5
12/05/2013	4	10.4	3.5
13/05/2013	4.1	14.6	1.5
14/05/2013	4.5	2.1	1.2
15/05/2013	4.2	16.7	0.0
16/05/2013	3	0.0	0.0
17/05/2013	no data	0.0	0.0
18/05/2013	5	2.1	0.0
19/05/2013	3.9	0.0	0.0
20/05/2013	8.4	6.3	0.0
21/05/2013	9.5	4.2	0.0
22/05/2013	7.2	10.4	4.5
23/05/2013	4.1	0.0	0.0
24/05/2013	3.3	0.0	0.7
25/05/2013	5.7	0.0	0.0
26/05/2013	5.8	0.0	0.0
27/05/2013	no data	2.1	0.0
28/05/2013	5.4	0.0	5.0
29/05/2013	5.9	4.2	2.2
30/05/2013	5.4	16.7	22.9
31/05/2013	4.7	2.1	1.1
1/06/2013	8.1	31.3	0.0

[a] as recorded at DSITIA's ambient air monitoring site at Rocklea.

Note: missing data due to intermittent problems with filter exchange mechanism on the Partisol® sampler which occurred between site visits.

Table 24: 24-hour $PM_{2.5}$ concentrations measured at the Fairfield (East) monitoring site during the pre-veneering monitoring period, 6 March to 1 May 2013, together with daily wind frequency from the direction of the rail corridor and rainfall.

Sampling day	24-hour $PM_{2.5}$ concentration ($\mu g/m^3$)	Proportion of winds from direction of rail corridor (%)	Rainfall[a] (mm)	Sampling day	24-hour $PM_{2.5}$ concentration ($\mu g/m^3$)	Proportion of winds from direction of rail corridor (%)	Rainfall[a] (mm)
6/03/2013	4.6	8.3	0.8	4/04/2013	4.8	18.8	1.8
7/03/2013	5.1	14.6	0.0	5/04/2013	4.7	31.3	0.7
8/03/2013	4.8	18.8	0.2	6/04/2013	4.9	50.0	0.0
9/03/2013	3.8	14.6	1.1	7/04/2013	4.5	43.8	1.5
10/03/2013	5.1	35.4	0.0	8/04/2013	4.3	35.4	0.5
11/03/2013	6.8	22.9	1.1	9/04/2013	4.2	37.5	2.5
12/03/2013	8.4	33.3	0.7	10/04/2013	5.2	35.4	0.0
13/03/2013	6.7	47.9	0.0	11/04/2013	4.4	27.1	0.1
14/03/2013	5.9	52.1	0.0	12/04/2013	6.3	56.3	9.5
15/03/2013	6.9	43.8	0.0	13/04/2013	4.4	64.6	18.6
16/03/2013	9.1	52.1	0.0	14/04/2013	5.4	56.3	0.0
17/03/2013	9.7	54.2	0.0	15/04/2013	8.7	52.1	0.0
18/03/2013	5.7	20.8	0.0	16/04/2013	8.5	56.3	4.6
19/03/2013	4.4	22.9	0.0	17/04/2013	7.7	50.0	4.6
20/03/2013	3.2	18.8	0.1	18/04/2013	8.1	70.8	0.0
21/03/2013	no data	39.6	0.0	19/04/2013	13.6	58.3	0.0
22/03/2013	6.5	52.1	0.0	20/04/2013	9.8	85.4	0.0
23/03/2013	6.1	47.9	0.0	21/04/2013	5.3	35.4	0.0
24/03/2013	4.7	58.3	16.3	22/04/2013	7.1	37.5	0.0
25/03/2013	5.6	25.0	0.0	23/04/2013	11.8	56.3	0.0
26/03/2013	5.1	6.3	0.0	24/04/2013	11.4	43.8	0.0
27/03/2013	5.8	29.2	1.1	25/04/2013	8.5	64.6	0.0
28/03/2013	6.2	25.0	0.0	26/04/2013	8.8	43.8	0.0
29/03/2013	5.9	47.9	0.0	27/04/2013	8.8	45.8	0.0
30/03/2013	6.4	0.0	0.0	28/04/2013	8.1	58.3	0.0
31/03/2013	6.3	70.5	14.7	29/04/2013	7.8	52.1	0.0
1/04/2013	5.6	42.9	0.1	30/04/2013	7.3	43.8	0.0
2/04/2013	5.9	20.8	0.0	1/05/2013	8.8	56.3	0.0
3/04/2013	6.8	35.4	0.0				

[a] as recorded at DSITIA's ambient air monitoring site at Rocklea.

Note: missing data due to a problem with the filter exchange mechanism on the Partisol® sampler.

Table 25: 24-hour $PM_{2.5}$ concentrations measured at the Fairfield (East) monitoring site during the post-veneering monitoring period, 2 May to 2 July 2013, together with daily wind frequency from the direction of the rail corridor and rainfall.

Sampling day	24-hour $PM_{2.5}$ concentration ($\mu g/m^3$)	Proportion of winds from direction of rail corridor (%)	Rainfall[a] (mm)	Sampling day	24-hour $PM_{2.5}$ concentration ($\mu g/m^3$)	Proportion of winds from direction of rail corridor (%)	Rainfall[a] (mm)
2/05/2013	7.5	35.4	0.0	2/06/2013	6.0	72.9	0.7
3/05/2013	6.7	25.0	0.0	3/06/2013	5.5	50.0	0.0
4/05/2013	9.5	70.8	0.0	4/06/2013	8.9	70.8	0.0
5/05/2013	10.5	35.4	0.0	5/06/2013	9.8	68.8	0.0
6/05/2013	6.5	27.1	0.0	6/06/2013	11.0	45.8	0.2
7/05/2013	4.3	41.7	0.0	7/06/2013	10.8	66.7	0.0
8/05/2013	3.8	33.3	0.0	8/06/2013	8.6	68.8	7.3
9/05/2013	4.7	43.8	1.0	9/06/2013	4.5	29.2	3.9
10/05/2013	6.7	50.0	1.0	10/06/2013	3.7	81.3	31.1
11/05/2013	7.4	50.0	4.5	11/06/2013	6.0	54.2	0.7
12/05/2013	4.7	58.3	3.5	12/06/2013	6.3	68.8	7.3
13/05/2013	5.0	56.3	1.5	13/06/2013	8.6	58.3	0.0
14/05/2013	5.7	89.6	1.2	14/06/2013	no data	95.8	0.0
15/05/2013	3.6	60.4	0.0	15/06/2013	no data	93.8	0.0
16/05/2013	no data	54.2	0.0	16/06/2013	no data	60.4	0.0
17/05/2013	no data	72.9	0.0	17/06/2013	no data	68.8	0.0
18/05/2013	0.3	52.1	0.0	18/06/2013	no data	66.7	0.0
19/05/2013	0.4	62.5	0.0	19/06/2013	no data	50.0	0.0
20/05/2013	1.1	58.3	0.0	20/06/2013	no data	70.8	2.7
21/05/2013	9.8	79.2	0.0	21/06/2013	no data	77.1	6.2
22/05/2013	8.2	81.3	4.5	22/06/2013	no data	66.7	0.0
23/05/2013	4.4	62.5	0.0	23/06/2013	no data	58.3	0.0
24/05/2013	3.7	85.4	0.7	24/06/2013	no data	52.1	0.0
25/05/2013	4.0	60.4	0.0	25/06/2013	no data	81.3	0.0
26/05/2013	6.0	58.3	0.0	26/06/2013	no data	60.4	0.0
27/05/2013	7.1	58.3	0.0	27/06/2013	5.7	66.7	1.1
28/05/2013	6.7	44.7	5.0	28/06/2013	5.5	64.6	2.7
29/05/2013	5.7	37.5	2.2	29/06/2013	4.7	58.3	2.6
30/05/2013	6.4	41.7	22.9	30/06/2013	4.6	85.4	9.5
31/05/2013	7.0	29.2	1.1	1/07/2013	3.0	97.9	19.9
1/06/2013	8.8	54.2	0.0				

[a] as recorded at DSITIA's ambient air monitoring site at Rocklea.

Note: missing data due to intermittent problems with filter exchange mechanism on the Partisol® sampler which occurred between site visits.

Table 26: 24-hour $PM_{2.5}$ concentrations measured at the Coorparoo (North) monitoring site during the pre-veneering monitoring period, 5 March to 1 May 2013, together with daily wind frequency from the direction of the rail corridor and rainfall.

Sampling day	24-hour $PM_{2.5}$ concentration (μg/m^3)	Proportion of winds from direction of rail corridor (%)	Rainfall[a] (mm)	Sampling day	24-hour $PM_{2.5}$ concentration (μg/m^3)	Proportion of winds from direction of rail corridor (%)	Rainfall[a] (mm)
5/03/2013	5.0	91.7	1.2	3/04/2013	6.8	60.4	0.0
6/03/2013	4.2	91.7	0.8	4/04/2013	4.6	77.1	1.8
7/03/2013	5.4	85.4	0.0	5/04/2013	4.4	83.3	0.7
8/03/2013	4.6	81.3	0.2	6/04/2013	2.9	58.3	0.0
9/03/2013	8.3	85.4	1.1	7/04/2013	3.6	43.8	1.5
10/03/2013	6.0	64.6	0.0	8/04/2013	4.0	60.4	0.5
11/03/2013	7.2	77.1	1.1	9/04/2013	3.6	60.4	2.5
12/03/2013	7.4	66.7	0.7	10/04/2013	3.5	64.6	0.0
13/03/2013	7.0	54.2	0.0	11/04/2013	3.7	75.0	0.1
14/03/2013	4.6	47.9	0.0	12/04/2013	4.7	79.2	9.5
15/03/2013	8.6	58.3	0.0	13/04/2013	4.1	45.8	18.6
16/03/2013	13.0	41.7	0.0	14/04/2013	5.6	39.6	0.0
17/03/2013	10.1	45.8	0.0	15/04/2013	8.8	50.0	0.0
18/03/2013	6.9	75.0	0.0	16/04/2013	9.2	39.6	4.6
19/03/2013	23.2	72.9	0.0	17/04/2013	9.2	50.0	4.6
20/03/2013	no data	91.7	0.1	18/04/2013	8.4	22.9	0.0
21/03/2013	no data	52.1	0.0	19/04/2013	no data	33.3	0.0
22/03/2013	no data	54.2	0.0	20/04/2013	no data	12.5	0.0
23/03/2013	no data	31.3	0.0	21/04/2013	no data	56.3	0.0
24/03/2013	no data	31.3	16.3	22/04/2013	7.6	54.2	0.0
25/03/2013	no data	72.9	0.0	23/04/2013	12.9	37.5	0.0
26/03/2013	4.8	81.3	0.0	24/04/2013	11.4	56.3	0.0
27/03/2013	4.9	70.8	1.1	25/04/2013	9.3	37.5	0.0
28/03/2013	6.2	72.9	0.0	26/04/2013	9.4	52.1	0.0
29/03/2013	5.5	54.2	0.0	27/04/2013	8.0	45.8	0.0
30/03/2013	6.7	100.0	0.0	28/04/2013	5.5	43.8	0.0
31/03/2013	6.4	28.6	14.7	29/04/2013	8.2	41.7	0.0
1/04/2013	5.3	45.8	0.1	30/04/2013	7.9	43.8	0.0
2/04/2013	6.2	62.5	0.0	1/05/2013	9.1	47.9	0.0

[a] as recorded at DSITIA's ambient air monitoring site at Rocklea.

Note: missing data due to intermittent problems with filter exchange mechanism on the Partisol® sampler which occurred between site visits.

Table 27: 24-hour $PM_{2.5}$ concentrations measured at the Coorparoo (North) monitoring site during the post-veneering monitoring period, 2 May to 2 July 2013, together with daily wind frequency from the direction of the rail corridor and rainfall.

Sampling day	24-hour $PM_{2.5}$ concentration ($\mu g/m^3$)	Proportion of winds from direction of rail corridor (%)	Rainfall[a] (mm)	Sampling day	24-hour $PM_{2.5}$ concentration ($\mu g/m^3$)	Proportion of winds from direction of rail corridor (%)	Rainfall[a] (mm)
2/05/2013	8.9	68.8	0.0	2/06/2013	5.3	25.0	0.7
3/05/2013	no data	60.4	0.0	3/06/2013	5.9	33.3	0.0
4/05/2013	10.6	22.9	0.0	4/06/2013	8.4	31.3	0.0
5/05/2013	11.3	56.3	0.0	5/06/2013	9.2	14.6	0.0
6/05/2013	6.3	64.6	0.0	6/06/2013	10.0	52.1	0.2
7/05/2013	3.1	60.4	0.0	7/06/2013	10.7	37.5	0.0
8/05/2013	3.5	68.8	0.0	8/06/2013	8.0	41.7	7.3
9/05/2013	4.3	62.5	1.0	9/06/2013	4.2	93.8	3.9
10/05/2013	7.0	45.8	1.0	10/06/2013	3.6	22.9	31.1
11/05/2013	5.6	41.7	4.5	11/06/2013	5.6	47.9	0.7
12/05/2013	4.4	35.4	3.5	12/06/2013	10.4	16.7	7.3
13/05/2013	6.0	31.3	1.5	13/06/2013	4.9	22.9	0.0
14/05/2013	3.0	12.5	1.2	14/06/2013	no data	2.1	0.0
15/05/2013	4.5	29.2	0.0	15/06/2013	3.0	8.3	0.0
16/05/2013	7.5	25.0	0.0	16/06/2013	7.0	22.9	0.0
17/05/2013	4.9	22.9	0.0	17/06/2013	4.4	16.7	0.0
18/05/2013	4.6	25.0	0.0	18/06/2013	5.5	8.3	0.0
19/05/2013	3.7	14.6	0.0	19/06/2013	6.1	14.6	0.0
20/05/2013	7.1	27.1	0.0	20/06/2013	6.7	18.8	2.7
21/05/2013	9.0	18.8	0.0	21/06/2013	7.4	16.7	6.2
22/05/2013	9.3	4.2	4.5	22/06/2013	7.4	29.2	0.0
23/05/2013	2.3	27.1	0.0	23/06/2013	7.4	20.8	0.0
24/05/2013	2.1	4.2	0.7	24/06/2013	8.6	14.6	0.0
25/05/2013	3.2	12.5	0.0	25/06/2013	5.6	20.8	0.0
26/05/2013	5.9	43.8	0.0	26/06/2013	4.8	22.9	0.0
27/05/2013	6.8	43.8	0.0	27/06/2013	8.1	27.1	1.1
28/05/2013	6.0	47.9	5.0	28/06/2013	9.5	47.9	2.7
29/05/2013	5.4	66.7	2.2	29/06/2013	4.9	45.8	2.6
30/05/2013	6.0	27.1	22.9	30/06/2013	1.9	10.4	9.5
31/05/2013	6.3	50.0	1.1	1/07/2013	2.6	2.1	19.9
1/06/2013	8.7	37.5	0.0	2/07/2013	no data	2.2	0.0

[a] as recorded at DSITIA's ambient air monitoring site at Rocklea.

Note: missing data due to intermittent problems with filter exchange mechanism on the Partisol® sampler which occurred between site visits.

Table 28: 24-hour $PM_{2.5}$ concentrations measured at the Chelmer background monitoring site during the pre-veneering monitoring period, 5 March to 1 May 2013, together with daily wind frequency from the direction of the rail corridor and rainfall.

Sampling day	24-hour $PM_{2.5}$ concentration ($\mu g/m^3$)	Proportion of winds from direction of rail corridor (%)	Rainfall[a] (mm)
5/03/2013	8.8	16.7	1.2
6/03/2013	5.3	25.0	0.8
7/03/2013	7.1	33.3	0.0
8/03/2013	6.6	31.3	0.2
9/03/2013	6.5	33.3	1.1
10/03/2013	6.2	41.7	0.0
11/03/2013	8.2	43.8	1.1
12/03/2013	13.6	50.0	0.7
13/03/2013	7.1	54.2	0.0
14/03/2013	6.3	62.5	0.0
15/03/2013	7.6	64.6	0.0
16/03/2013	5.8	56.3	0.0
17/03/2013	no data	56.3	0.0
18/03/2013	no data	25.0	0.0
19/03/2013	no data	35.4	0.0
20/03/2013	4.7	22.9	0.1
21/03/2013	5.5	56.3	0.0
22/03/2013	7.7	50.0	0.0
23/03/2013	4.7	43.8	0.0
24/03/2013	6.1	31.3	16.3
25/03/2013	5.4	37.5	0.0
26/03/2013	no data	37.5	0.0
27/03/2013	no data	43.8	1.1
28/03/2013	no data	56.3	0.0
29/03/2013	no data	50.0	0.0
30/03/2013	no data	22.9	0.0
31/03/2013	no data	70.8	14.7
1/04/2013	no data	64.6	0.1
2/04/2013	no data	70.8	0.0
3/04/2013	no data	64.6	0.1
4/04/2013	16.4	54.2	1.8
5/04/2013	7.1	47.9	0.7
6/04/2013	5.1	60.4	0.0
7/04/2013	no data	58.3	1.5
8/04/2013	8.1	58.3	0.5
9/04/2013	6.7	52.1	2.5
10/04/2013	4.5	47.9	0.0
11/04/2013	7.5	37.5	0.1
12/04/2013	8.7	62.5	9.5
13/04/2013	no data	85.4	18.6
14/04/2013	no data	75.0	0.0
15/04/2013	no data	52.1	0.0
16/04/2013	5.9	77.1	4.6
17/04/2013	6.0	50.0	4.6
18/04/2013	6.6	93.8	0.0
19/04/2013	13.9	91.7	0.0
20/04/2013	9.6	85.4	0.0
21/04/2013	5.8	60.4	0.0
22/04/2013	8.2	54.2	0.0
23/04/2013	no data	72.9	0.0
24/04/2013	9.1	25.0	0.0
25/04/2013	6.6	43.8	0.0
26/04/2013	7.1	0.0	0.0
27/04/2013	5.7	0.0	0.0
28/04/2013	6.2	4.2	0.0
29/04/2013	5.8	0.0	0.0
30/04/2013	5.1	4.2	0.0
1/05/2013	3.9	6.3	0.0

[a] as recorded at DSITIA's ambient air monitoring site at Rocklea.

Note: missing data due to intermittent problems with filter exchange mechanism on the Partisol® sampler which occurred between site visits.

Table 29: 24-hour $PM_{2.5}$ concentrations measured at the Chelmer background monitoring site during the post-veneering monitoring period, 2 May to 2 June 2013, together with daily wind frequency from the direction of the rail corridor and rainfall.

Sampling day	24-hour $PM_{2.5}$ concentration ($\mu g/m^3$)	Proportion of winds from direction of rail corridor (%)	Rainfall[a] (mm)
2/05/2013	6.1	25.0	0.0
3/05/2013	no data	79.2	0.0
4/05/2013	no data	95.8	0.0
5/05/2013	no data	54.2	0.0
6/05/2013	no data	47.9	0.0
7/05/2013	no data	45.8	0.0
8/05/2013	no data	41.7	0.0
9/05/2013	no data	52.1	1.0
10/05/2013	no data	66.7	1.0
11/05/2013	no data	72.9	4.5
12/05/2013	no data	81.3	3.5
13/05/2013	no data	83.3	1.5
14/05/2013	no data	100.0	1.2
15/05/2013	no data	89.6	0.0
16/05/2013	no data	75.0	0.0
17/05/2013	3.8	89.6	0.0
18/05/2013	5.4	97.9	0.0
19/05/2013	2.7	93.8	0.0
20/05/2013	6.1	91.7	0.0
21/05/2013	8.3	91.7	0.0
22/05/2013	7.4	83.3	4.5
23/05/2013	4.2	79.2	0.0
24/05/2013	3.0	100.0	0.7
25/05/2013	4.3	89.6	0.0
26/05/2013	6.7	83.3	0.0
27/05/2013	7.7	79.2	0.0
28/05/2013	5.9	66.7	5.0
29/05/2013	4.4	50.0	2.2
30/05/2013	5.7	77.1	22.9
31/05/2013	7.1	62.5	1.1
1/06/2013	8.2	66.7	0.0
2/06/2013	3.7	91.7	0.7

[a] as recorded at DSITIA's ambient air monitoring site at Rocklea.

Note: missing data due to intermittent problems with filter exchange mechanism on the Partisol® sampler which occurred between site visits.

Table 30: Monthly dust deposition sampling results for the rail corridor monitoring sites collected during the pre- and post-veneering monitoring periods, March to July 2013.

Monitoring site	Position relative to rail line	Date deployed	Date collected	Days sampled	Dust deposition rate ($mg/m^2/day$)					Winds from direction of rail line (%)	Rainfall (mm)[a]
					Total solids	Insoluble solids	Ash (mineral)	Combustible (organic) matter	Soluble solids		
Oakey	North	6/03/13	4/04/13	29	97	39	6	33	58	18	43
		4/04/13	2/05/13	28	47	25	8	17	22	28	19
		2/05/13	6/06/13	35	27	17	17	0	10	34	39
	South	6/03/13	4/04/13	29	331	39	7	32	292	82	43
		4/04/13	2/05/13	28	152	84	13	71	68	72	19
		2/05/13	6/06/13	35	130	33	26	7	97	66	39
Willowburn (Toowoomba)	East	6/03/13	4/04/13	29	Extensive algal growth invalidated sample					14	105
		4/04/13	2/05/13	28	52	25	5	20	27	19	24
		2/05/13	6/06/13	35	106	33	13	20	73	32	74
	West	6/03/13	4/04/13	29	Extensive algal growth invalidated sample					86	105
		4/04/13	2/05/13	28	98	11	4	7	87	81	24
		2/05/13	6/06/13	35	134	14	7	7	120	68	74
Dinmore	North	6/03/13	5/04/13	30	131	36	9	27	95	66	78
		5/04/13	3/05/13	28	90	67	36	31	23	58	74
		3/05/13	5/06/13	31	30	20	10	10	10	90	46
	South	6/03/13	5/04/13	30	171	66	7	59	105	32	78
		5/04/13	3/05/13	28	117	50	9	41	67	36	74
		3/05/13	5/06/13	31	117	37	17	20	80	6	46
Tennyson	North	5/03/13	4/04/13	30	180	103	16	87	77	76	82
		4/04/13	3/05/13	29	112	104	27	77	8	79	80
		3/05/13	4/06/13	30	79	46	23	13	33	88	40
		4/06/13	3/07/13	29	43	24	17	7	19	89	89
	South	5/03/13	4/04/13	30	121	115	34	81	6	23	82
		4/04/13	9/05/13	35	230	90	6	84	140	21	80
		9/05/13	4/06/13	26	73	63	50	13	10	13	40
		4/06/13	3/07/13	29	73	50	40	10	23	14	89

Table 30 (cont.): Monthly dust deposition sampling results for the rail corridor monitoring sites collected during the pre- and post-veneering monitoring periods, March to July 2013

Monitoring site	Position relative to rail line	Date deployed	Date collected	Days sampled	Dust deposition rate ($mg/m^2/day$)					Winds from direction of rail line (%)	Rainfall (mm)[a]
					Total solids	Insoluble solids	Ash (mineral)	Combustible (organic) matter	Soluble solids		
Fairfield	East	5/03/13	4/04/13	30	208	46	12	34	162	32	90
		4/04/13	2/05/13	28	124	18	5	13	106	50	82
		2/05/13	4/06/13	33	77	20	10	10	57	55	46
		4/06/13	3/07/13	29	40	23	13	10	17	68	98
	West	5/03/13	4/04/13	30	197	57	19	38	140	68	90
		4/04/13	2/05/13	28	210	112	16	96	98	50	82
		2/05/13	4/06/13	33	74	27	7	20	47	46	46
		4/06/13	3/07/13	29	43	24	17	7	19	33	98
Coorparoo	North	4/03/13	4/04/13	31	263	107	7	100	156	65	92
		4/04/13	3/05/13	29	247	106	13	93	141	51	93
		3/05/13	4/06/13	32	31	24	7	17	7	35	52
		4/06/13	3/07/13	29	43	27	20	7	16	25	88
	South	4/03/13	4/04/13	31	251	108	6	102	143	27	92
		4/04/13	3/05/13	29	272	119	9	110	153	30	93
		3/05/13	4/06/13	32	44	27	7	20	17	44	52
		4/06/13	3/07/13	29	41	20	13	7	21	44	88
Chelmer	East	4/03/13	5/04/13	33	161	55	5	50	106	45	81
		5/04/13	2/05/13	27	194	50	5	45	144	48	85
		2/05/13	5/06/13	34	56	36	13	23	20	77	52

[a] Indicative only – estimated from the volume of water collected in the dust deposition bottle.

Unshaded rows indicate samples collected during the pre-veneering monitoring period. Shaded rows indicate samples collected during the post-veneering monitoring period.

Table 31: Composition of the insoluble solids fraction of the monthly deposited dust samples collected at the rail corridor monitoring sites, March to June 2013.

Monitoring site	Position relative to rail line	Month	Surface coverage (%)[a]									
			Black particles			Inorganic and minerals		Biological			General organic	
			Coal	Soot	Black rubber dust	Soil or rock dust	Copper sludge	Photosynthetic slime and fungi	Insect debris	Plant debris (general)	Fibres (miscellaneous)	Paint
Oakey	North	March	20	ND	10	60	ND	ND	trace	10	ND	ND
		April	10	ND	5	55	30	ND	trace	ND	ND	ND
		May	10	trace	10	80	trace	ND	trace	trace	ND	ND
	South	March	10	trace	10	80	ND	ND	trace	trace	ND	ND
		April	10	ND	10	40	40	ND	trace	trace	ND	ND
		May	20	trace	10	70	ND	ND	trace	trace	ND	ND
Willowburn (Toowoomba)	East	March	trace	trace	ND	60	ND	ND	30	10	ND	ND
		April	20	trace	ND	60	ND	ND	10	10	ND	ND
		May	trace	ND	ND	20	ND	60	20	ND	ND	ND
	West	March	Polysaccharide slime and copper sludge encrusted the deposit, particles were not visible									
		April	10	trace	10	80	ND	ND	trace	trace	ND	ND
		May	5	trace	10	75	ND	ND	10	trace	ND	ND
Dinmore	North	March	20	ND	10	50	20	ND	ND	ND	trace	ND
		April	10	ND	10	80	trace	ND	trace	trace	ND	ND
		May	10	trace	30	60	trace	ND	trace	trace	ND	ND
	South	March	20	ND	10	50	ND	ND	10	10	ND	ND
		April	20	ND	10	50	ND	ND	10	10	ND	ND
		May	10	trace	trace	80	trace	ND	10	trace	ND	ND
Tennyson	North	March	10	ND	20	60	ND	ND	trace	10	ND	ND
		April	10	ND	10	50	30	ND	trace	trace	ND	ND
		May	20	ND	10	60	10	ND	trace	trace	ND	ND
		June	10	trace	20	70	trace	ND	trace	trace	trace	ND
	South	March	10	trace	10	70	trace	ND	trace	10	ND	trace
		April	10	trace	10	70	ND	ND	trace	10	ND	trace
		May	10	trace	trace	90	ND	ND	trace	trace	ND	ND
		June	5	trace	10	85	trace	ND	trace	trace	trace	ND

Table 31 (cont.): Composition of the insoluble solids component of the monthly deposited dust samples collected at the rail corridor monitoring sites, March to June 2013.

Monitoring site	Position relative to rail line	Month	Surface coverage (%)[a]									
			Black particles			Inorganic and minerals		Biological			General organic	
			Coal	Soot	Black rubber dust	Soil or rock dust	Copper sludge	Photosynthetic slime and fungi	Insect debris	Plant debris (general)	Fibres (miscellaneous)	Paint
Fairfield	East	March	10	trace	10	70	ND	ND	ND	10	ND	ND
		April	10	trace	10	70	trace	ND	trace	10	ND	ND
		May	10	trace	20	70	trace	ND	trace	trace	ND	ND
		June	trace	trace	10	90	trace	ND	trace	trace	trace	ND
	West	March	10	trace	trace	60	ND	ND	10	20	ND	trace
		April	10	trace	20	60	ND	ND	trace	10	trace	ND
		May	5	ND	10	85	trace	ND	trace	trace	ND	ND
		June	10	trace	10	80	trace	ND	trace	trace	trace	ND
Coorparoo	North	March	10	ND	10	60	trace	ND	10	10	ND	ND
		April	trace	ND	10	80	trace	ND	trace	10	ND	ND
		May	20	ND	10	70	trace	ND	trace	trace	trace	ND
		June	5	trace	20	75	trace	ND	trace	trace	ND	ND
	South	March	20	ND	10	60	ND	ND	trace	10	ND	ND
		April	20	trace	10	50	ND	ND	trace	20	trace	trace
		May	20	ND	20	60	trace	ND	trace	trace	trace	ND
		June	trace	trace	20	70	trace	ND	10	trace	trace	ND
Chelmer	East	March	ND	ND	ND	60	ND	20	10	10	trace	ND
		April	ND	trace	ND	70	ND	ND	10	20	ND	ND
		May	trace	trace	10	90	trace	ND	trace	trace	trace	ND

[a] The uncertainty in the measurement of surface coverage is ±5 per cent

ND = not detected

Unshaded rows indicate samples collected during the pre-veneering monitoring period. Shaded rows indicate samples collected during the post-veneering monitoring period.

Table 32: Distribution of 10-minute average PM_{10} concentration change associated with the passage of different train types at the Tennyson (North) monitoring site during the pre- and post-veneering monitoring periods.

Change in PM_{10} concentration ($\mu g/m^3$)	Pre-veneering period (5 March to 1 May 2013)				Post-veneering period (2 May to 2 July 2013)			
	Frequency of change (%)				Frequency of change (%)			
	Loaded Coal (310 trains)	Empty Coal (378 trains)	Other Freight (271 trains)	Passenger (106 trains)	Loaded Coal (196 trains)	Empty Coal (205 trains)	Other Freight (131 trains)	Passenger (39 trains)
< -100	0.0	0.6	0.0	0.0	0.0	0.0	0.0	0.0
-75 to -100	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
-50 to -75	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
-30 to -50	0.0	0.3	2.2	1.9	0.0	0.0	0.0	2.6
-20 to -30	0.3	0.3	0.4	0.0	0.0	0.0	0.0	0.0
-10 to -20	2.6	2.1	3.3	2.8	0.5	0.5	0.0	2.6
-5 to -10	5.5	3.7	1.8	4.7	0.5	1.5	0.8	2.6
-2 to -5	16.8	8.7	12.5	9.4	3.6	4.9	6.1	7.7
-1 to -2	14.5	9.3	10.0	14.2	3.6	5.4	3.8	15.4
0 to -1	5.2	12.4	11.1	15.1	5.1	3.9	4.6	10.3
0 to +1	16.1	27.0	22.9	18.9	27.6	34.1	25.2	38.5
+1 to +2	11.6	13.8	11.8	16.0	30.1	29.3	26.7	12.8
+2 to +5	10.6	10.1	12.9	10.4	20.4	15.1	20.6	0.0
+5 to +10	10.0	6.3	5.9	4.7	7.1	4.9	9.9	5.1
+10 to +20	5.2	3.7	2.6	1.9	1.5	0.0	1.5	2.6
+20 to +30	0.6	0.5	1.1	0.0	0.0	0.5	0.0	0.0
+30 to +50	0.6	1.1	1.1	0.0	0.0	0.0	0.0	0.0
+50 to +75	0.3	0.0	0.0	0.0	0.0	0.0	0.8	0.0
+75 to +100	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0
> +100	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0

Table 33: Distribution of 10-minute average PM_{10} concentration change associated with the passage of different train types at the Fairfield (East) monitoring site during the post-veneering monitoring period.

Change in PM_{10} concentration ($\mu g/m^3$)	Post-veneering period (2 May to 2 July 2013)			
	Frequency of change (%)			
	Loaded Coal (65 trains)	Empty Coal (73 trains)	Other Freight (41 trains)	Passenger (104 trains)
< -100	0.0	0.0	0.0	0.0
-75 to -100	0.0	0.0	0.0	0.0
-50 to -75	0.0	1.4	0.0	0.0
-30 to -50	0.0	0.0	0.0	0.0
-20 to -30	0.0	0.0	0.0	0.0
-10 to -20	1.5	0.0	0.0	0.0
-5 to -10	1.5	0.0	0.0	0.0
-2 to -5	6.2	4.1	4.9	3.8
-1 to -2	9.2	8.2	17.1	14.4
0 to -1	6.2	12.3	0.0	11.5
0 to +1	38.5	38.4	41.5	43.3
+1 to +2	21.5	15.1	22.0	18.3
+2 to +5	10.8	17.8	12.2	6.7
+5 to +10	0.0	1.4	0.0	1.0
+10 to +20	3.1	0.0	2.4	1.0
+20 to +30	0.0	1.4	0.0	0.0
+30 to +50	0.0	0.0	0.0	0.0
+50 to +75	0.0	0.0	0.0	0.0
+75 to +100	0.0	0.0	0.0	0.0
> +100	1.5	0.0	0.0	0.0

Table 34: Distribution of 10-minute average PM_{10} concentration change associated with the passage of different train types at the Coorparoo (North) monitoring site during the pre- and post-veneering monitoring periods.

Change in PM_{10} concentration ($\mu g/m^3$)	Pre-veneering period (5 March to 1 May 2013) Frequency of change (%)				Post-veneering period (2 May to 2 July 2013) Frequency of change (%)			
	Loaded Coal (92 trains)	Empty Coal (133 trains)	Other Freight (28 trains)	Passenger (252 trains)	Loaded Coal (94 trains)	Empty Coal (138 trains)	Other Freight (23 trains)	Passenger (203 trains)
< -100	0.0	0.8	0.0	0.0	0.0	0.0	0.0	0.0
-75 to -100	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
-50 to -75	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
-30 to -50	0.0	0.0	0.0	0.0	0.0	0.7	0.0	0.0
-20 to -30	1.1	0.0	3.6	0.0	0.0	0.0	0.0	0.0
-10 to -20	0.0	1.5	0.0	1.2	0.0	0.0	0.0	0.5
-5 to -10	0.0	2.3	3.6	1.2	1.1	0.7	8.7	2.0
-2 to -5	5.4	6.0	0.0	8.7	7.4	9.4	4.3	9.9
-1 to -2	6.5	14.3	7.1	10.3	12.8	11.6	8.7	13.3
0 to -1	8.7	9.0	14.3	14.3	9.6	9.4	13.0	12.3
0 to +1	25.0	27.1	28.6	35.7	22.3	22.5	21.7	32.5
+1 to +2	21.7	18.8	17.9	13.5	22.3	22.5	13.0	19.7
+2 to +5	23.9	14.3	17.9	9.5	18.1	16.7	21.7	6.4
+5 to +10	6.5	6.0	0.0	3.6	4.3	5.8	8.7	2.5
+10 to +20	1.1	0.0	7.1	2.0	2.1	0.7	0.0	1.0
+20 to +30	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
+30 to +50	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
+50 to +75	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
+75 to +100	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
> +100	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Table 35: Distribution of 10-minute average $PM_{2.5}$ concentration change associated with the passage of different train types at the Tennyson (North) monitoring site during the pre- and post-veneering monitoring periods.

Change in $PM_{2.5}$ concentration (µg/m^3)	Pre-veneering period (5 March to 1 May 2013)				Post-veneering period (2 May to 2 July 2013)			
	Frequency of change (%)				Frequency of change (%)			
	Loaded Coal (310 trains)	Empty Coal (378 trains)	Other Freight (271 trains)	Passenger (106 trains)	Loaded Coal (196 trains)	Empty Coal (205 trains)	Other Freight (131 trains)	Passenger (39 trains)
< -50	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
-30 to -50	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
-20 to -30	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
-10 to -20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
-5 to -10	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0
-2 to -5	0.3	1.6	1.5	1.9	0.0	2.0	0.8	5.1
-1 to -2	3.2	3.7	5.5	3.8	4.6	2.0	3.8	7.7
0 to -1	25.2	19.6	19.9	10.4	9.7	5.9	6.1	15.4
0 to +1	63.5	67.2	64.2	83.0	63.3	62.4	56.5	64.1
+1 to +2	6.1	4.8	7.7	0.9	16.8	20.5	24.4	5.1
+2 to +5	0.6	2.4	0.7	0.0	4.6	6.8	7.6	2.6
+5 to +10	1.0	0.5	0.0	0.0	1.0	0.0	0.0	0.0
+10 to +20	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0
+20 to +30	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
+30 to +50	0.0	0.0	0.0	0.0	0.0	0.0	0.8	0.0
> +50	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0

Table 36: Distribution of 10-minute average $PM_{2.5}$ concentration change associated with the passage of different train types at the Fairfield (East) monitoring site during the post-veneering monitoring period.

Change in $PM_{2.5}$ concentration ($\mu g/m^3$)	Post-veneering period (2 May to 2 July 2013)			
	Frequency of change (%)			
	Loaded Coal (65 trains)	Empty Coal (73 trains)	Other Freight (41 trains)	Passenger (104 trains)
< -50	0.0	0.0	0.0	0.0
-30 to -50	0.0	1.4	0.0	0.0
-20 to -30	0.0	0.0	0.0	0.0
-10 to -20	0.0	0.0	0.0	0.0
-5 to -10	1.5	0.0	0.0	0.0
-2 to -5	4.6	2.7	4.9	0.0
-1 to -2	7.7	4.1	7.3	8.7
0 to -1	13.8	12.3	14.6	19.2
0 to +1	47.7	56.2	46.3	64.4
+1 to +2	18.5	17.8	24.4	5.8
+2 to +5	1.5	4.1	0.0	1.0
+5 to +10	3.1	0.0	2.4	1.0
+10 to +20	0.0	1.4	0.0	0.0
+20 to +30	0.0	0.0	0.0	0.0
+30 to +50	0.0	0.0	0.0	0.0
> +50	1.5	0.0	0.0	0.0

Table 37: Distribution of 10-minute average $PM_{2.5}$ concentration change associated with the passage of different train types at the Coorparoo (North) monitoring site during the pre- and post-veneering monitoring periods.

Change in $PM_{2.5}$ concentration ($\mu g/m^3$)	Pre-veneering period (5 March to 1 May 2013)				Post-veneering period (2 May to 2 July 2013)			
	Frequency of change (%)				Frequency of change (%)			
	Loaded Coal (92 trains)	Empty Coal (133 trains)	Other Freight (28 trains)	Passenger (252 trains)	Loaded Coal (94 trains)	Empty Coal (138 trains)	Other Freight (23 trains)	Passenger (203 trains)
< -50	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
-30 to -50	0.0	0.8	0.0	0.0	0.0	0.0	0.0	0.0
-20 to -30	0.0	0.0	0.0	0.0	0.0	0.7	0.0	0.0
-10 to -20	1.1	0.0	3.6	0.4	0.0	0.0	0.0	0.0
-5 to -10	0.0	1.5	0.0	1.2	0.0	0.0	0.0	0.5
-2 to -5	1.1	4.5	3.6	3.2	1.1	1.4	8.7	2.5
-1 to -2	7.6	8.3	0.0	11.1	9.6	12.3	8.7	14.3
0 to -1	14.1	19.5	17.9	19.0	18.1	17.4	17.4	20.2
0 to +1	34.8	36.8	50.0	45.6	42.6	38.4	21.7	46.3
+1 to +2	29.3	20.3	3.6	9.9	16.0	23.2	26.1	11.8
+2 to +5	10.9	8.3	14.3	7.5	10.6	5.1	17.4	3.9
+5 to +10	1.1	0.0	7.1	2.0	2.1	1.4	0.0	0.5
+10 to +20	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
+20 to +30	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
+30 to +50	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
> +50	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Appendix 2: Department of Health comments on particle exposure levels at rail corridor monitoring sites

Queensland Government

Department of Health

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Mr David Wainwright
Director - Air Quality Sciences
Science Delivery Division
Department of Science, Information Technology, Innovation and the Arts
GPO Box 523
BRISBANE QLD 4001

Dear Mr Wainwright

Thank you for the opportunity to comment on the draft *Western-Metropolitan Rail Systems Coal Dust Monitoring Program* report prepared by the Department of Science, Information Technology, Innovation and the ARTS (DSITIA) on the investigation of coal dust emissions from trains transporting coal to the Port of Brisbane from mines in Southern Queensland.

I note that monitoring was conducted over a four month period at six locations (Oakey, Willowburn (Toowoomba), Dinmore, Tennyson, Fairfield and Coorparoo) along the Western and Metropolitan rail systems used to transport coal to the Port of Brisbane and one background location (Chelmer) on a section of the Metropolitan rail system not used by coal trains. Measurements were taken prior to and following the commencement of the coal wagon veneering trial by New Acland Mine.

The air monitoring results reveal that airborne dust concentrations complied with the air quality objectives in the Queensland *Environmental Protection (Air) Policy 2008* (EPP Air) at all of the six rail corridor monitoring sites during both the pre- and post-veneering monitoring periods. The monitoring results were also similar to airborne dust concentration results in other areas of Brisbane.

The potential health effects of dust are closely related to particle size. The size range of airborne particles varies from less than 0.1 micrometre (µm) up to about 500 µm. Human health effects of airborne dust are mainly associated with particles less than 10 µm in size (commonly termed PM_{10}), which are small enough to be inhaled into the lower respiratory tract. Particles less than 2.5 µm in size ($PM_{2.5}$) have a higher probability of deposition in the smaller conducting airways and alveoli of the lungs. Nuisance effects can be caused by particles of any size, but are most commonly associated with those larger than 20 µm.

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Based on the currently available evidence, the air quality objectives in the Queensland EPP Air are considered to be protective of public health to the extent that any health impact of the pollutant is not likely to be discernible from the background rate of the health condition. Therefore, for people living along the rail corridor, the dust concentrations measured during the investigation are unlikely to result in any additional adverse health effects. However, even where the air quality objectives are met, potential adverse health effects may be experienced by highly susceptible individuals, such as the elderly or others with significant pre-existing cardio-pulmonary diseases.

Should you require any further information in relation to this matter, please contact Ms Uma Rajappa, Director, Environmental Hazards, Environmental Health Regulation and Standards, Health Protection Unit, on telephone (07) 3328 9338.

Yours sincerely

Dr Michael Cleary
Deputy Director-General
Health Service and Clinical Innovation Division
24/09/2013