REPORT

Tonkin+Taylor

LPC Coal Stockyard Air Quality Assessment

Response to section 92 request for further information

Prepared for

Lyttelton Port Company Limited

Prepared by

Tonkin & Taylor Ltd

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1 Question 1 – 30-day versus 15-day deposition monitoring

Request:

We note that it was not possible to reconcile the 15-day dust deposition results with the 30-day dust deposition results. PDP consider that if the monitoring and sample analysis processes have been followed, then the reconciliation of the results from these two different exposure periods should have been simple and straight forward. This raises questions around the reliability of these monitoring results. Please:

- *Provide an explanation of potential reasons why reconciliation was not possible;*
- *Discuss any implications of this on the assessment conclusions which are based on dust deposition results; and*
- *Explain how this issue will be overcome for the proposed future dust deposition monitoring programme.*

Response:

Verum Group, who currently undertakes the deposition monitoring for LPC, advises that there is a 'positive bias' towards the 15-day monitoring gauges – meaning that the 15-day samples report higher deposition rates than the 30-day samples. The exact reason for this has not been established, although possible causes suggested by Verum Group are:

- Obscuration of fine coal dust by degrading organic matter in the 30-day monitoring samples.
- Biological digestion of coal fines by organic processes in the 30-day monitoring samples.

With regards to the implications, the higher values were used in all cases to inform the assessment of impacts at those locations affected. Consequently, we consider that there are no implications in terms of the conclusions reached in our assessment (notably Sections 5.3 and 5.6) based on deposition monitoring data.

At this stage it is not clear that the issue of the difference in 15-day and 30-day values can be readily overcome. Accordingly, it is proposed that the current monitoring regime continue.

2 Question 2 – Analysis of non-coal dust deposition data

Request:

PDP understand that the deposition monitoring measures coal and other dust sources. No information is provided in the Report on the deposition monitoring results for other dust sources. Please provide a comparison between the other source results obtained from the deposition monitoring and the source apportion monitoring.

Response:

Figure 2.1 presents a 'box and whisker plot' comparing coal and non-coal derived insoluble dust deposition rates. From these plots the following conclusions are made:

- Non-coal dust deposition rates for non-residential locations are broadly similar to those experienced in residential areas, with the exception of Sites 3 and 6 (which are both located within the LPC site).
- The high peak value for site 3 occurs for January 2018, with other monthly values being much lower and similar to those in residential areas. The cause of this individual peak value is unclear and is an outlier relative to the other data for site 3.
- Site 6 has recorded substantially higher values than for the other monitoring sites. This site is within the port area and is located closest to the reclamation area of the port. Accordingly, the results were significantly influenced by reclamation activities, which have progressively moved away from this monitoring location over time. This is evident by the substantial reduction in dust levels recorded for this location as illustrated in Figure 2.2.

Deposition rates for the most impacted residential location (site 10a) shows a monthly pattern of non-coal dust deposition rates that is similar to other residential locations, with peak rates occurring in early 2018 (see Figure 2.3)

In terms of a comparison between the deposition monitoring data and the source apportionment monitoring, a meaningful comparison cannot be made, nor is useful for the evaluation of effects associated with the coal stockyard, for the following reasons:

- Source apportionment analysis was for suspended PM_{10} and $PM_{2.5}$ particles, focusing on the particle fraction that is concerned with human health effects. By comparison, the dust deposition monitoring included all insoluble particle sizes with a focus on dust nuisance effects.
- The most significant particle type identified by the PM_{10} and $PM_{2.5}$ source apportionment study was marine aerosols (sea salt). By contrast, sea salt is not apparent in the reported dust deposition monitoring as it only measures insoluble solids – sea salt is soluble and is consequently not measured.

The second part of the s92 question seeks a comparison of the dust deposition data with the source apportionment data. However, we do not consider a meaningful statistical comparison can be provided for the following reasons:

- The source apportionment data was in relation to measured concentrations of PM_{10} and $PM_{2.5}$ which are not readily comparable to the dust deposition data due to the different particle size fractions, especially where relatively low concentrations and deposition rates are recorded (as is the case in this instance). In this regard we note that the IAQM (2016)[1] notes the following:

[1] IAQMA 2016. Guidance on the Assessment of Mineral Dust Impacts for Planning. Institute of Air Quality Management. United Kingdom. May 2016 (v1.1).

"High levels of PM_{10} may be associated with high levels of deposited dust. However, <u>there is no direct correlation between the two</u>; indeed, as airborne particles fall out of the parcel of dust-laden air, the suspended PM concentration is reduced"

- The source apportionment data covers time-periods of 24 hours whereas the dust deposition data covers 14-day or more commonly 30-day periods.
- The monitoring programme associated with the source apportionment study covered a time-period of approximately 4 months, meaning there are only 4 data-points associated with each deposition monitoring site. Given the small number of dust deposition datapoints it is not possible to draw any meaningful statistical comparison.

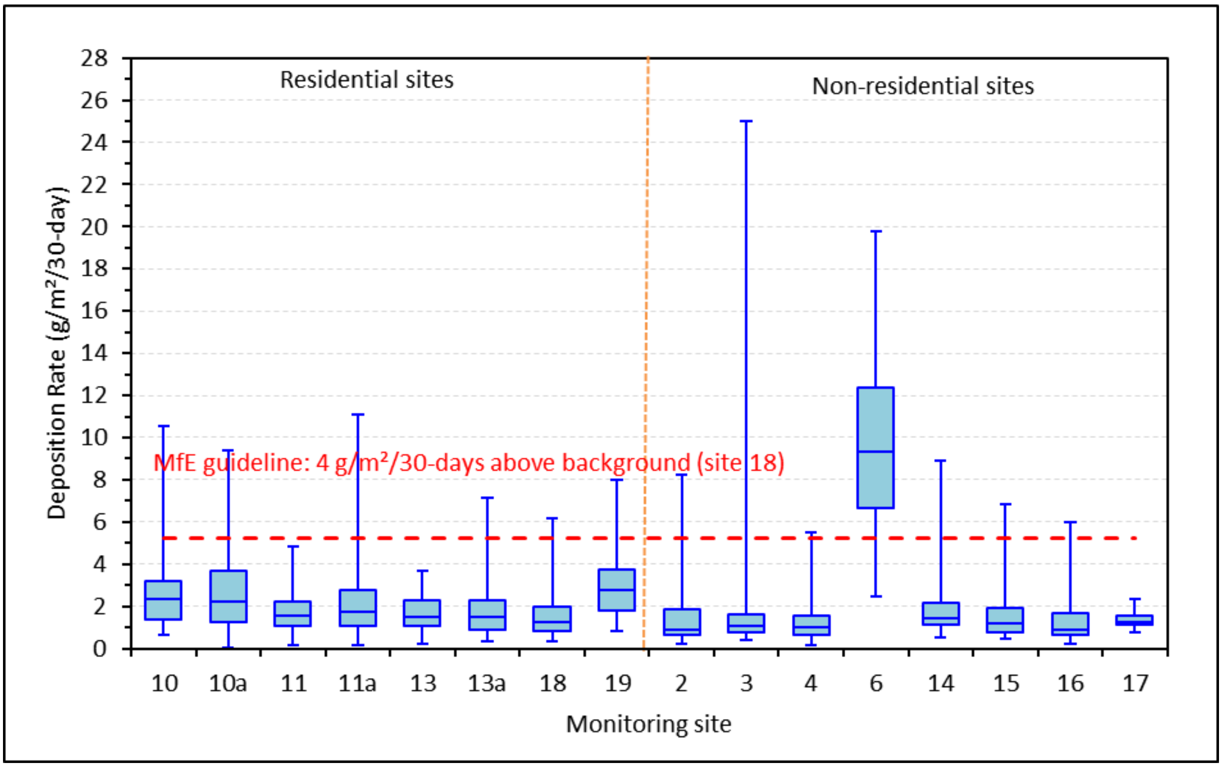

Figure 2.1: Box and whisker plot of non-coal dust deposition rates by monitoring site location – 2016 to 2020.

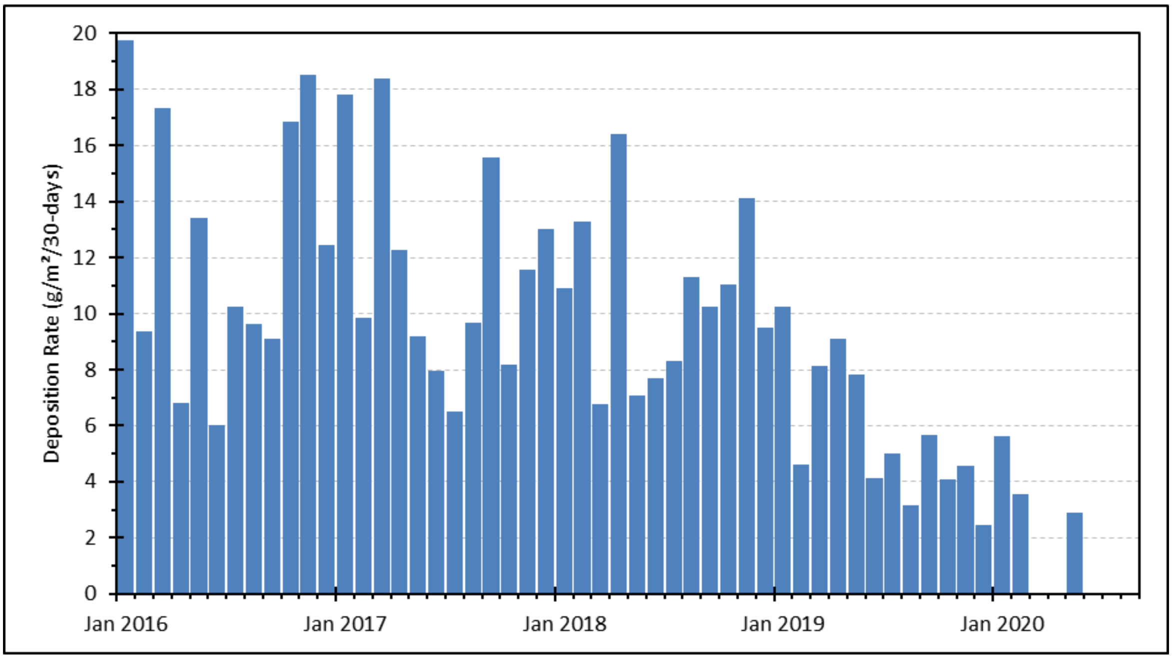

Figure 2.2: Monthly non-coal deposition rates for Site 6

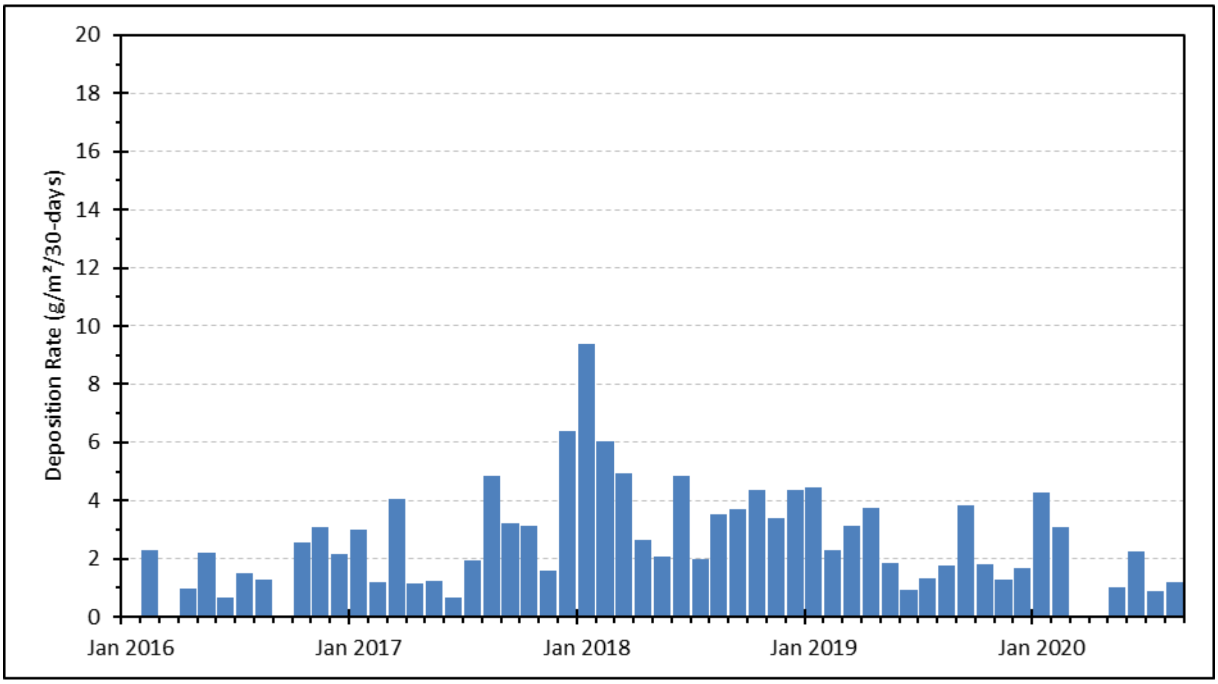

Figure 2.3: Monthly non-coal deposition rates for Site 10a

3 Question 3 – Contour plot for coal dust deposition monitoring data

Request

Interpolation appears to have been used to generate isopleths of dust deposition rates. Please explain the interpolation method and input data used. Please highlight any key uncertainties with this method and discuss how these may affect the results or conclusions drawn from the results.

Response

The preparation of the isopleths showing the approximate spatial distribution of coal deposition rates (as presented in Appendix A of the T+T Air Quality Assessment) was used to provide a "broad indication" of the spatial pattern of measured dust deposition, informing our view that deposition impacts are influenced by local topography and meteorology, as well as distance from the coal stock yard. This was useful in that it did corroborate and therefore give weight to the results of the dispersion modelling.

The plots were generated using the software package 'Surfer', which is widely used in New Zealand for preparing contour plots of air dispersion modelling results. The method used to grid the data was the 'kriging' method, which is a geospatial interpolation method. A sufficiently fine grid resolution (25 m) was used to ensure the locations of individual monitoring sites (13 sites) were accurately reproduced in the output plot. For locations that are not in between monitoring sites, the resulting isopleths will result in greater uncertainty, notably over the coal stockyard and over water.

4 Question 4 – FIDOL assessment

Request

The FIDOL assessment provided is purely qualitative. The site is well served with meteorological and coal stockyard activity data, and PDP considers that this data could have been used to inform the FIDOL assessment. Therefore, please consider this data and provide a quantitative assessment of the frequency and duration of potential impacts. Please also consider recommended buffer distances and revise the assessment of intensity and location to incorporate these factors.

Response

A FIDOL assessment is a qualitative assessment tool, but the frequency and duration of exposure events are informed by wind conditions and are an aspect that can be quantified. In this instance, the nearest and most impacted sensitive location (residential houses at the eastern end of Lyttelton) are all downwind of the coal stockyard under broadly the same wind directions, which to a large degree negates the need to do a specific analysis by wind direction.

In our experience, a more granular FIDOL assessment that considers wind analysis is used where sensitive locations surround a site, meaning that there will be differing wind exposure conditions for those locations. In such circumstances, a detailed wind exposure analysis is useful to highlight the locations that have a particularly high frequency and/or duration of exposure. This in turn helps to inform mitigation strategies to address such high-risk wind exposure conditions. However, this was not done in this instance, nor is it considered to be necessary given the nearest adjoining Lyttelton community is downwind under broadly the same wind conditions.

Nevertheless, T+T has undertaken a wind exposure analysis for nominal receptor locations closest to the coal stockyard as indicated in Figure 4.1. For each receptor, the range of wind directions that it is downwind of the coal stockyard and coal ship berth were determined. These are summarised in Table 4.1.

Figure 4.1: Nominal receptor locations for wind exposure analysis.

Table 4.1: Bearing range from receptor location to coal stock yard and coal ship berth

Receptor	Bearing start (°N)	Bearing end (°N)
R1	80	156
R2	75	155
R3	72	155
R4	67	151
R5 (ambient monitoring site)	62	148
R6	62	138
R7	60	125

It is T+T's experience that wind erosion of exposed surfaces typically starts to occur when the hourly average wind speed (as measured at a 10 m high mast) is 7 m/s or greater during dry weather conditions. Figure 4.2 presents frequency analysis data for winds that are 7 m/s or greater, and at a height of 10 m above ground level, using the two-year dataset for the coal stockyard derived from the CALMET dataset for the dispersion modelling analysis (which incorporates measured data from the coal stockyard). This data was filtered to include only days when rainfall did not occur (taken as days when rainfall is less than 1 mm/day). As expected, the analysis shows the exposure for the receptors is broadly the same at all receptor locations, with receptors being downwind of the coal stock yard on dry days for 1.1% to 1.5% of hours in a year.

Given this we have produced a frequency exposure chart in Figure 4.3 for the same receptor locations given in Figure 4.2 but for winds that are 4 m/s or greater. From this it is evident that these lighter winds conditions affect Receptors 5, 6 and 7 the most. This finding corroborates the analysis provided in the T+T Air Quality Assessment. Furthermore, Receptor R5 in this analysis represents the location of the ambient monitoring site that was established to inform the assessment. As such, this analysis supports the choice of location for the ambient monitoring site as being a representative of the most impacted community location.

Overall, the refined meteorological analysis does not change the conclusions reached in our FIDOL analysis presented in Section 5.5 of the T+T Air Quality Assessment. In particular, it does not alter our conclusions regarding the frequency and duration of potential exposure.

The second part of the s92 question seeks consideration of recommended buffer distance guidelines and how those guidelines might affect the FIDOL assessment.

Separation distance guidelines are often used to inform a FIDOL assessment in so far as screening locations that should be considered as part of such an assessment, with those locations beyond the relevant separation distance guideline being deemed as having negligible effects assuming good practice mitigation is applied. This can be especially useful for new activities where there is no other information to inform an assessment of potential intensity of impacts. In this instance, there is extensive coal dust deposition data collected over a network of monitoring sites and over a long period of time. This deposition data provides a more direct measure of dust intensity at various distances from the coal stock yard and at a qualitative level is corroborated with anecdotal community feedback.

Notwithstanding the above, Table 4.2 provides a summary of relevant separation distance guidelines published by various Australian States and the UK Institute of Air Quality Management (IAQM)[2]. The guidelines vary between 300 m and 1,000 m, and includes dust emissions associated with large open

[2] IAQMA 2016. Guidance on the Assessment of Mineral Dust Impacts for Planning. Institute of Air Quality Management. United Kingdom. May 2016 (v1.1).

cut coal mines. The guidance from the IAQM is not specific to coal handling operation, but instead covers various mineral related activities including coal.

The LPC coal stock yard, while of a moderate in scale, is not comparable as a source of dust to a large open cut coal mine. In this regard the IAQM (2016) notes the following:

> "The cited radius of effect of 1 km is based on studies carried out many years ago around open-face coal mines and there appears to be no firm evidence that such a distance can be applied to other mineral developments (most of which involve less dust generating activities that an open-cast mine) as a screening distance for PM_{10} effects"

With regards to the NT EPA and WT EPA guidance for bulk material loading and unloading, we note that the separation guidance values vary depending on whether a closed material loading system is used. The LPC coal stockyard partly comprises a closed material loading system for the loading of vessels (covered or underground conveyors and the use of the jet-slinger to load coal into the hull of the ships).

We consider WA EPA and NT EPA separation distances most accurately apply to this situation. However, given the material handling is partly enclosed the separation distance should be somewhere between 300 m and 1,000 m. We consider a separation distance in the order of approximately 600 m is suitable basis for identifying sensitive locations within which a FIDOL assessment is required, i.e., it is used as a screening tool. In this regard, the FIDOL assessment was provided in Section 5.5 of the Air Quality Assessment and expanded on in Section 4of this document.

Table 4.2: Separation distance guidance

Australian state guidance	Activity	Recommended separation distance
EPA Victoria[3]	Open cut coal mine: Harvesting, crushing, screening, stockpiling and conveying of coal.	1,000 m
EPA South Australia[4]	Coal handling and storage	1,000 m (more than 1 tonne per day handling or 50 tonnes storage)
Western Australia EPA[5]	Bulk material loading or unloading (including coal)	1,000 m (open materials loading system) 300 m (closed materials loading system)
Northern Territory EPA[6]	Bulk material loading or unloading (including coal)	1,000 m (open materials loading system) 300 m (closed materials loading system)
ACT EPA	NR	
UK IAQMA	Mineral dust	400 m (hard rock) 250 m (soft rock)

Table Notes:

NR means the guideline does not include a relevant activity

[3] EPA Victoria 2013. Recommended Separation distances for industrial residual air emissions. Publication number 1518.
[4] SA EPA 2016. Evaluation distances for effective air quality and noise management. South Australia Environment Protection Authority. ISBN 978-1-921495-76-2
[5] WA EPA 2015. Draft Environmental Assessment Guideline for Separation Distances between industrial and sensitive land uses. Western Australia Environment Projection Authority. Draft for consultation.
[6] NT EPA 2017. Guideline: Recommended Land Use Separation Distances. Northern Territory Environment Protection Authority. Version 1.

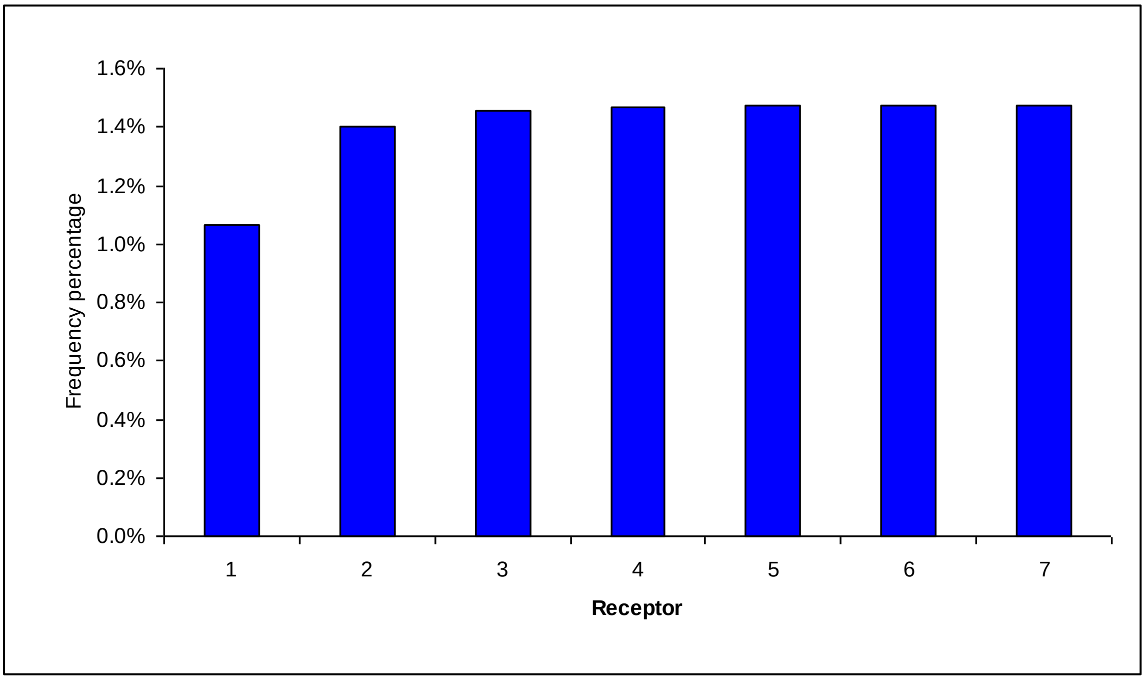

Figure 4.2: Wind exposure for each receptor location when the wind speed is 7 m/s or greater

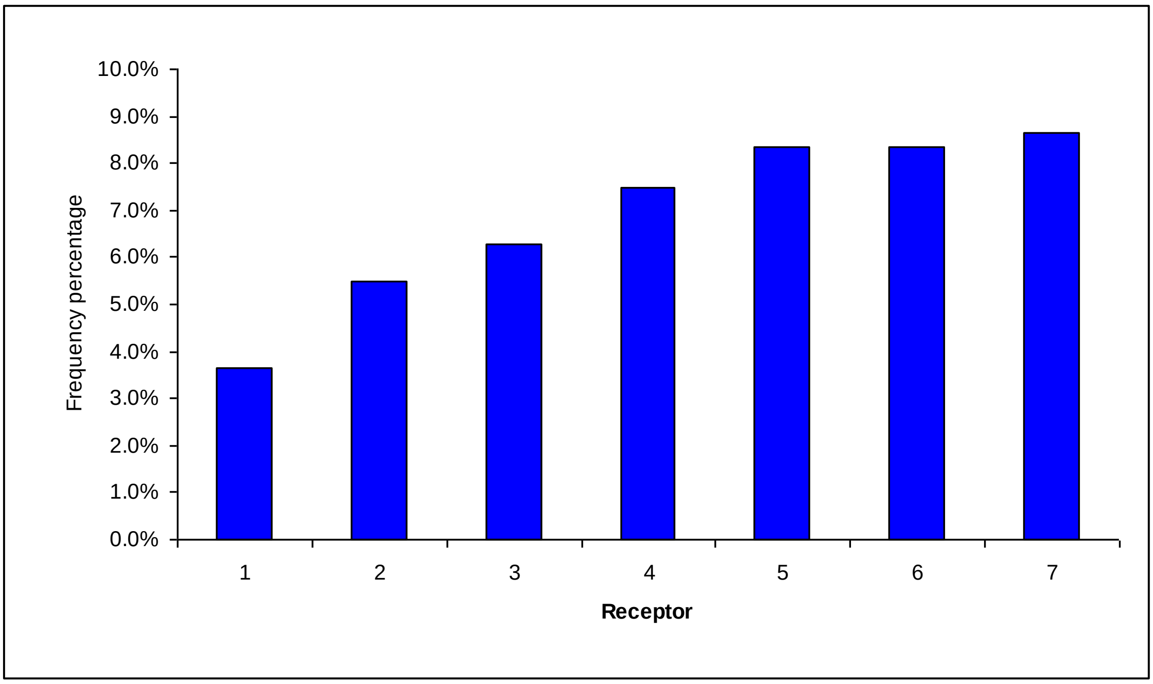

Figure 4.3: Wind exposure for each receptor location when the wind speed is 4 m/s or greater

5 Question 5 – Consultation

Request

From the pre-application consultation process, PDP understands that a door-to-door household survey was to be undertaken in the Lyttelton area that aimed to explore/understand the dust impacts experienced in the area. Please confirm whether the survey was undertaken. If it was not undertaken, please explain how community consultation has been incorporated into the assessment.

If it was undertaken, then:

- *Please provide details of the questions asked, dates of the survey and the number of households surveyed;*
- *Please explain why the results of this survey were not presented in the assessment;*
- *If possible, please provide a summary of the results of the survey aiming to ground truth the respective elements of the FIDOL assessment, particularly the offensiveness of the dust; and*
- *Please compare the overall findings of the survey with the conclusions reached from the FIDOL assessment.*

Response

LPC undertook an early exercise to door knock nearby residents to the Coal Stockyard ahead of public communications of the reconsenting project being released on 21 October 2020. The exercise was not a survey in the strict sense. Instead, its purpose was to inform residents of the upcoming application and to collect informal information of their observations of dust over the recent years.

The door knocking exercise was undertaken by LPC staff on 6 and 7 October 2020 at the locations indicated in Figure 5.1. Each address was provided an information sheet, which was left in letter boxes if no resident was home.

The general feedback received by residents that had lived in the area decades was that they could remember coal dust impacts being far worse in the 90's prior to sprinkler suppression systems being installed. Many residents also commented that they saw it as being part of living by a working port. From the feedback it was also clear that areas towards the port had observed dust from coal on occasion; however, those residences closer to central Lyttelton were not concerned.

Figure 5.1: Area door knocked on the 6th and 7th of October 2020.

6 Question 6 – Human health impacts

Request

The key method used by T+T to undertake the assessment of effects human health is to compare monitored ambient air quality data with the relevant health impact assessment guidelines, and this assessment has been carried out in line with expected good practice.

However, there is a significant body of literature that details the health impacts specifically related to coal dust (e.g., NIOSH 2011[7]). PDP consider that relying solely on the numerical PM_{10} and $PM_{2.5}$ health impact guidelines may not accurately assess all the potential health impacts specifically related to coal dust.

Therefore, please review the human health impacts of coal dust as detailed in the literature and confirm (or otherwise) the appropriateness of relying on the numerical PM_{10} and $PM_{2.5}$ health impact guidelines.

Response

The following section on the potential human health effects of coal dust has been prepared by Dr Lyn Denison, T+T's Technical Lead for Human Health Risk Assessments. She has more than 30 years of experience in air quality and human health risk assessment and was the Principal Scientist at Environment Protection Authority of Victoria (EPA) for 17 years. In that time at the EPA, Lyn was involved in State and National Policy Development for Air Quality and led the development of the Protocol for Environmental Management (Mining and Extractive Industries). She also is a sessional member of Planning Panels Victoria and was on the Assessment Committees for East West Link and the Stawell Big Hill Development Project EES. In the New Zealand context, Lyn conducted reviews for the development of air quality guidelines for the Ministry for the Environment in New Zealand and assisted in the development of the national policy for air quality and public consultation.

There is significant evidence of adverse health effects associated with exposure to coal dust in occupational settings. In the US, respirable dust is defined as particles less than 10 micrometres (PM_{10}) (µm) in size (ACGIH 2007)[8]. In coal mining, overexposure to respirable coal mine dust can lead to coal workers' pneumoconiosis (CWP), commonly known as black lung (NIOSH 2021)[9]. In addition, miners can be exposed to high levels of respirable silica dust, which can cause silicosis. These diseases are associated with exposure to high levels of coal dust for prolonged periods of time usually greater than 10 years (NIOSH 2021). A review of the literature through PubMed has not found any evidence of these diseases occurring in communities near to mine sites due to community exposure to dust from the mine.

In NZ the WorkSafe Workplace Exposure Standards developed to protect against these health effects are 3 mg/m³ for respirable coal dust and 0.05 mg/m³ for respirable crystalline silica. Both these standards are 8-hour time weighted averages (TWA). The modelled concentrations of PM_{10} and $PM_{2.5}$ associated with the operation of the Lyttelton Coal Stockyard are orders of magnitude below the WES TWA standard for coal dust at the most exposed receptors.

There are very few ambient air quality standards for coal dust available internationally. In the US, the Texas Centre for Environmental Quality (TCEQ) has established an Effects Screening Level for

[7] National Institute for Occupational Safety and Health (2011). Coal Mine Dust Exposures and Associated Health Outcomes, https://www.qld.gov.au/environment/pollution/monitoring/management/emissions
[8] ACGIH [2007]. Appendix C: Particle size-selective sampling criteria for airborne particulate matter. In: 2007 TLVs and BEIs. Cincinnati, OH: American Conference of Governmental Industrial Hygienists.
[9] NIOSH Mining Program Information Circular IC 9532, (2021) Best Practices for Dust Control in Coal Mining Second Edition

Coal Dust that is equivalent to the United States National Ambient Air Quality Standard (NAAQS)[10] for PM_{10}, which is set at a 24-hour average of 150 µg/m³. This approach is based on the assumption that meeting the NAAQS for PM_{10} is protective of potential health effects of coal dust and that there are no additional health effects due to the coal dust itself apart from the size of the particle. The NZ equivalent standard is the National Environmental Standard for Air Quality (NESAQ) which gives a 24-hour average PM_{10} concentration of 50 µg/m³. The ambient air quality monitoring conducted for the location of the most exposed community location shows PM_{10} concentrations within the potentially exposed community are below the NZ PM_{10} standard that has been derived to protect public health.

The health effects associated with coal dust are linked to the size of the particles and the crystalline silica content. Particles and crystalline silica in the respirable fraction are those that pose the greatest risk. Several community-based epidemiological studies have been undertaken to investigate the health effects of particles, PM_{10} and $PM_{2.5}$, from various sources and have concluded that there is not sufficient evidence that allows health effects to be attributed to specific sources and that the strongest evidence is related to the size fraction (Hime et al., 2018). Therefore, any potential risk to the local community from emissions from the Coal Stockyard will be associated with PM_{10} and $PM_{2.5}$ as well as any respirable crystalline silica (RCS) present in the coal dust.

Epidemiological studies indicate that occupational exposure to RCS is associated with adverse health effects and general community (non-occupational) exposure to RCS is unlikely to present significant risks to public health. The World Health Organization's Concise International Chemical Assessment Document on Crystalline Silica, Quartz (CICAD, 2000)[11] states that "there are no known adverse health effects associated with the non-occupational exposure to quartz".

Both toxicological and epidemiological data indicate there are levels of exposure of RCS below which there is zero risk of developing silicosis and lung cancer. Crystalline silica toxicity has been extensively investigated leading to a widely accepted toxicological mechanism involving chronic inflammation and oxidative stress. These toxicological mechanisms are consistent with a threshold exposure for both silicosis and lung cancer (HSE, 2003)[12].

A review of the literature has shown that coal dust can contain up to 20% crystalline silica. There is very little information on RCS in ambient air. In Victoria Australia monitoring and assessment of RCS for mining operations has been required since 2007 for new or expanded mines. Monitoring conducted near the Hazelwood Coal mine, an open cut coal mine, has shown that ambient levels in the nearby town of Morwell was below the limit of detection of the analysis method which was 1.7 µg/m³. This is well below the ambient air quality guideline adopted in Victoria of 3 µg/m³ as an annual average. It is also well below the WES TWA of 50 µg/m³ to protect workers health.

As part of a Health Risk Assessment conducted for a new coal mine in NSW (Toxikos, 2014)[13] RCS concentrations were predicted from OHS monitoring. Of the six personal monitoring samples analysed for RCS only one was above the level of detection. This value was used to predict the off-site RCS concentrations which was considered a conservative assumption. The predicted off-site RCS from the mining operations at the maximum impacted receptor was 0.1 µg/m³ as an annual average, well below the public health guideline of 3 µg/m³.

Another Health Risk Assessment conducted for a new mine at Wallarah in NSW assumed that the RCS concentration was 10% of the total PM_{10} contribution from the mine operation. The RCS

[10] https://www.epa.gov/criteria-air-pollutants/naaqs-table
[11] CICAD 2000. Concise International Chemical Assessment Document No. 24 Crystalline Silica, Quartz (2000) WHO International Programme on Chemical Safety
[12] HSE 2003. Recommendation from the Scientific Committee on Occupational Exposure Limits for Silica, Crystalline (respirable dust), SCOEL/SUM/94, SCOEL, November 2003.
[13] Toxikos 2014. Health Risk Assessment Tahmoor South Coal Project

concentration was estimated to be 0.16 µg/m³ again well below the public health guideline of 3 µg/m³. The estimate of 10% was based on a report to the Monterey Bay Unified Air Pollution Control District of California, Ruble and Goldsmith (1993)[14] reported the PM_{10} and crystalline silica levels measured at two sites adjacent to a quarry in central coastal California. The mean PM_{10} concentrations for each site were 18.9 and 18.2 µg/m³ with mean crystalline silica concentrations of 1.33 and 1.10 µg/m³, respectively. The data show that 6 to 7% of the site-specific PM_{10} was crystalline silica. The use of 10% RCS was therefore a conservative assumption.

The period average PM_{10} concentrations attributed to the coal for the Gilmore Terrace, Lyttelton monitoring site (from the source apportionment study) was 3.5 µg/m³. Assuming RCS comprises 10% of this concentration, a period average of 0.35 µg/m³ is calculated. This is well below the guideline value of 3 µg/m³. In practice, the annual average contribution from the Coal Stockyard will be lower still given coal dust emissions during winter months will be much lower due to the cold and damp conditions. From the examples presented above it can be concluded that the health risk from RCS from the coal yard would be negligible.

[14] Ruble RP, Goldsmith DF. 1993. Ambient silica estimation from PM10 data: a tool for air pollution control. Presented at the Second International Symposium on Silica, Silicosis, and Cancer. San Francisco, CA, 28-30 October 1993.

7 Question 7 – K-factor adjustment for nephelometers

Request

T+T has followed good practice for ambient air quality monitoring by co-locating a BAM and nephelometer. The basic comparison of the 24-hour average concentrations measured by the two instruments is encouraging. Having co-located data allows a detailed comparison of data from the two different instruments to be made and facilitates the calculation of a k-factor which when applied to the nephelometer data gives a proxy for BAM equivalent data.

From the pre-application consultation process PDP understood that a site-specific k-factor would be calculated and applied to the nephelometer data. PDP can find no mention of this in the Report. Therefore, if it has not been done, please explain why, and discuss the potential implications on the results gained and conclusions drawn from the nephelometer data. Please also, if possible, calculate the k factor and apply that to the nephelometer data and provide an updated set of results and if necessary revised conclusions.

If it has been done, please provide information on the process and the k-factor calculated and show how it has been applied to the data.

Response

The determination of the site-specific K-factor and adjustment of the nephelometer data was undertaken by Mote Limited, which was contracted by LPC to undertake the ambient monitoring programme. Mote advises that a K-factor of 1.3 was applied to the nephelometer data and it was this data that was used to inform the analysis provided in Section 6.3 of the T+T Air Quality Assessment.

Additionally, Mote advises:

- ‘The [nephelometer] instruments are calibrated using polystyrene latex spheres of known index of refraction and diameter at multiple points to validate linearity. For the LPC monitoring investigation, we further verified the accuracy of each unit using a wood smoke particle generator at our Auckland laboratory, which was evaluated alongside a new ES642 a Teledyne T640 and an aerodynamic particle sizer (TSI 3320). The instruments were then co-located for 7 days immediately outside our Auckland office to verify the precision of the instruments. The difference in average 24-hour average concentration between the instruments is less than 2 micrograms per cubic metre.
- Following the field co-location with the Beta attenuation monitor at Gilmour terrace Lyttleton a K-factor of 1.3 was used for the instruments.’

8 Question 8 – Use of nephelometers for coal dust monitoring

Request

In PDP's experience nephelometers sometimes do not respond well to dark or black coloured particles. Confirming the responsiveness of the nephelometers to coal dust is particularly important given they become a key part of the monitoring strategy when coal throughput exceeds 1.75 million tonnes per annum. Please provide evidence that the nephelometers are responding usefully to coal dust. This evidence could include but not be limited to a statement from the equipment manufacture and comparing:

- *BAM and nephelometers 1-hour average concentrations when the monitoring site is down wind of the coal stockyard during windspeeds < 5 m/s;*
- *BAM and nephelometers 1-hour average concentrations when the BAM monitoring data shows peak impacts from the coal stockyard; and monitoring site is down wind of the coal stockyard during windspeeds < 5 m/s; and*
- *BAM and nephelometers 1-hour average concentrations during 6-hour periods that the source apportionment shows relatively high contribution of coal dust to total dust loading.*

Response

T+T's has sought advice from Mote Limited, who were contracted to undertake the ambient monitoring programme for LPC. On this matter Mote advises the following:

- The reflective and refractive properties of particles will influence both the accuracy and precision of the incident collimated laser (670 nm) and any resulting reported mass concentration. Dark coloured particles tend to have lower levels of reflectance and greater levels of light absorption in the visible spectral range. In a practical context, this means that there is the potential for dark coloured particles to be "under-reported" relative to lighter coloured particles. This is one of the primary reasons for co-locating the instruments at Gilmour Terrace and developing a site-specific correction factor (K-factor).
- Optical monitors can and are used for monitoring coal dust, with the provision that a site-specific correction factor needs to be used to ensure concentration data is meaningful.
- Mote Limited operate several optical instruments at coal mines in both New Zealand and Australia and routinely perform gravimetric corrections on the data by periodically co-locating reference or equivalent monitors with these instruments. Our experience has found that correction factors for optical instruments range from 0.9 to 4. The higher values apply in situations where the sub-bituminous coal comprises the majority (> 95%) of the particulate material being monitored.

Given Mote's advice, we consider that a nephelometer is an appropriate monitoring instrument for the purpose of real-time dust management associated with the operation of the coal stockyard. This is provided that a site-specific K-factor has been derived for the instrument.

Further to the above the purpose of using a nephelometer in this instance is not to establish concentrations of particulate matter for comparison against human health guidelines, which necessitates a high degree of accuracy and precision of the monitoring instrument. Instead, the purpose is simply to provide a pro-active monitoring system to alert site operations of elevated particulate concentrations to enable an on-site review of dust controls and where appropriate a reactive response. In this regard, we consider that a nephelometer is an appropriate choice of instrument for this purpose.

The three bullet points of the s92 question seek detailed comparison of the monitoring results for the BAM and nephelometers under different wind conditions when the monitoring site is downwind of the coal stockyard. The response in Section 9 below provides a revised analysis and comparison of the BAM and nephelometer data having identified an issue with the timestamp associated with the BAM and wind monitoring instruments. The corrected data in this section now shows good corelation between the BAM and nephelometer instruments located at Gilmore Terrace, notably with peak concentrations occurring for both instruments under the same wind direction and wind speed conditions. Notwithstanding this, we note that the source apportionment study found that contribution of coal to measured PM_{10} concentrations at Gilmore Terrace was a relatively small one relative to other source of particulate matter, which would make any meaningful comparison difficult.

9 Question 9 – $PM_{2.5}$ and PM_{10} data analysis

Request

If PDP understands the results correctly, T+T's analysis of the data shows that peak BAM PM_{10} and $PM_{2.5}$ concentrations occur with windspeeds of about 2 m/s. The peak PM_{10} concentrations occur when the wind direction is from the coal stock yard, and the peak $PM_{2.5}$ concentrations occur when wind direction is from north of coal stock yard. The peak PM_{10} concentrations occurring at low windspeeds seems counter intuitive to PDP.

Please provide an explanation of this considering the general rule of thumb that increased potential dust risk occurs with higher windspeeds. Please discuss the potential implications of this unexpected result on the conclusions reached on human health impacts using the ambient air quality monitoring data.

Response

A detailed analysis of the monitoring data from the BAMs, nephelometers and wind monitoring instruments has been undertaken by T+T in response to this query. From this, T+T has identified data derived from the BAMs and wind instruments were not correctly recording the date and time. This was confirmed by Mote Limited, which re-issued a corrected dataset. The identified errors were as follows, which affected the relationship analysis of the relationship between wind speed, wind direction and concentration:

- The recorded date and time for the BAMS was 12 hours behind the other datasets; and
- The recorded date and time for the wind instruments was out by 24 hours behind other the datasets.

Identification of the error by T+T was achieved through:

- Comparison of hourly average concentration readings for the BAM against those for the nephelometer instruments and against data from ECan's PM_{10} monitoring instrument at Woolston; and
- Comparison of the wind measurements against those measured by the Port's wind monitoring instrument at the Coal Stockyard.

The data for the nephelometer instruments was identified as having the correct date and time values.

A re-analysis of the BAM and nephelometer data has been undertaken using the dataset with the corrected date and time values as supplied by Mote. An update of Table 6.3 and Figure 6.2 of the T+T Air Quality Assessment are provided below as Table 9.1 and Figure 9.1. The revised data do not change the overall conclusions reached regarding the monitoring data.

A polar-plot comparing PM_{10} concentrations for the BAM and nephelometer is presented as Figure 9.3.From this revised analysis there is now greater agreement between the polar-plots for the BAM and nephelometer instruments at Gilmore Terrace, with peak concentrations occurring under east-northeast winds that are approximately 4 m/s (hourly average) and from the same general direction (see Figure 9.2).

While we generally agree with the 'rule of thumb' described in the s92 question that "*increased potential dust risk occurs with higher windspeeds",* we note that this does not necessarily imply a linear relationship with downwind particulate matter concentrations. This is shown by the results presented in Figure 9.2, where peak hourly concentrations are not associated with the strongest winds. This is because dust emissions generated at low to moderate winds will not disperse and dilute as rapidly as dust emission generated under high wind speeds.

While the polar-plots presented in Figure 9.2 indicate peak PM_{10} concentrations coming from the direction of the Coal Stockyard, analysis indicates this is not substantially due to emissions from the coal yard. In particular, a comparison of the results for the various nephelometers (presented in Figure 9.3) shows elevated concentrations at the upwind coal-yard nephelometer site also occur from the same easterly direction. This is consistent with the source apportionment study presented in the T+T Air Quality Assessment which indicates marine aerosols (sea salt) making up the majority of measured concentrations.

In summary, while the corrected data addresses the discrepancy in the comparison of the BAM and nephelometer data, the overall conclusions reached in the T+T Air Quality Assessment are unchanged.

Table 9.1: Updated summary of $PM_{2.5}$ and PM_{10} 24-hour average monitoring data (replaces Table 6.3 of the AQA – old values shown as strike-through text)

Parameter	$PM_{2.5}$		PM_{10}	
% data capture	~~95.4%~~	93.8%	~~100.0%~~	99.2%
Maximum 24-hour average concentration (µg/m³)	~~9.5~~	12.3	~~29.5~~	29.6
Relevant 24-hour average guideline/standard*	25		50	
Maximum as percentage of guideline/standard	~~38%~~	49%	~~59%~~	59%
Period average concentration (µg/m³)	~~4.9~~	4.9	~~10.5~~	10.6
99th%ile 24-hour average concentration (µg/m³)	~~8.5~~	8.3	~~20.8~~	20.6

Note * $PM_{2.5}$ WHO guideline 25 µg/m³; PM_{10} NES_{AQ} 50 µg/m³.

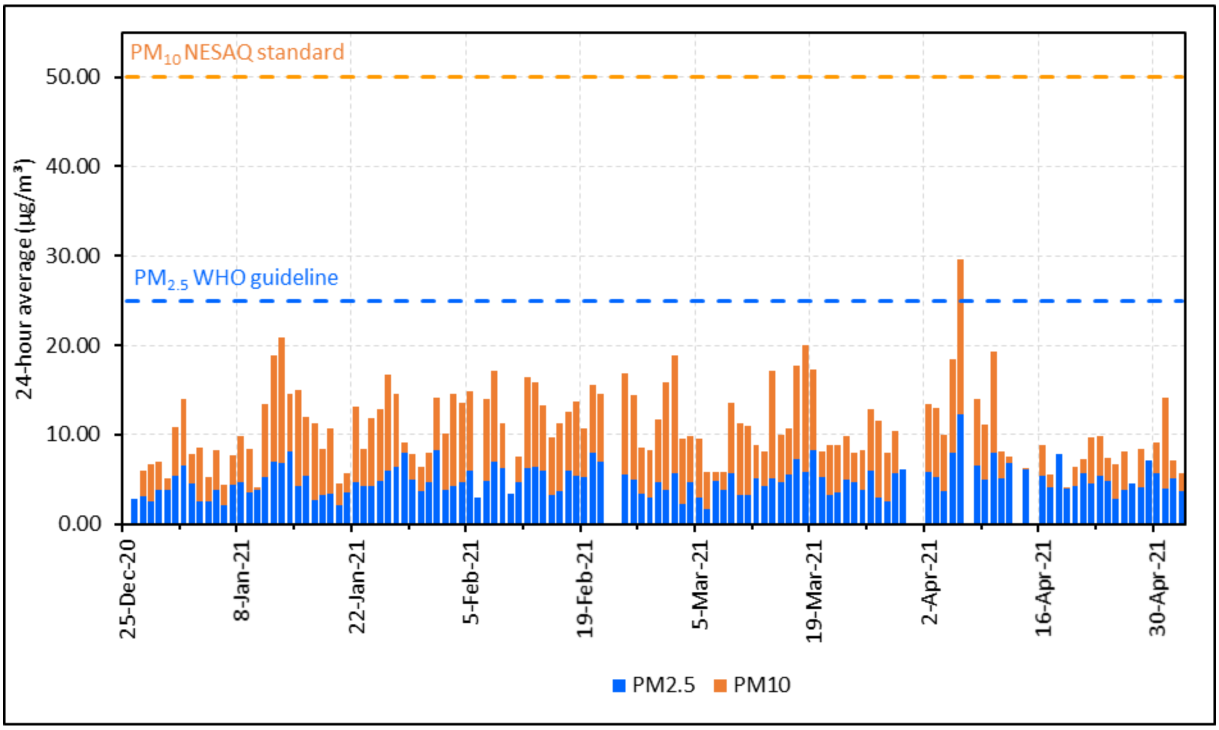

Figure 9.1: Updated monitoring data - Gilmore Terrace site measured 24-hour average $PM_{2.5}$ and PM_{10} for the monitoring period (replaced Figure 6.2 of the AQA)

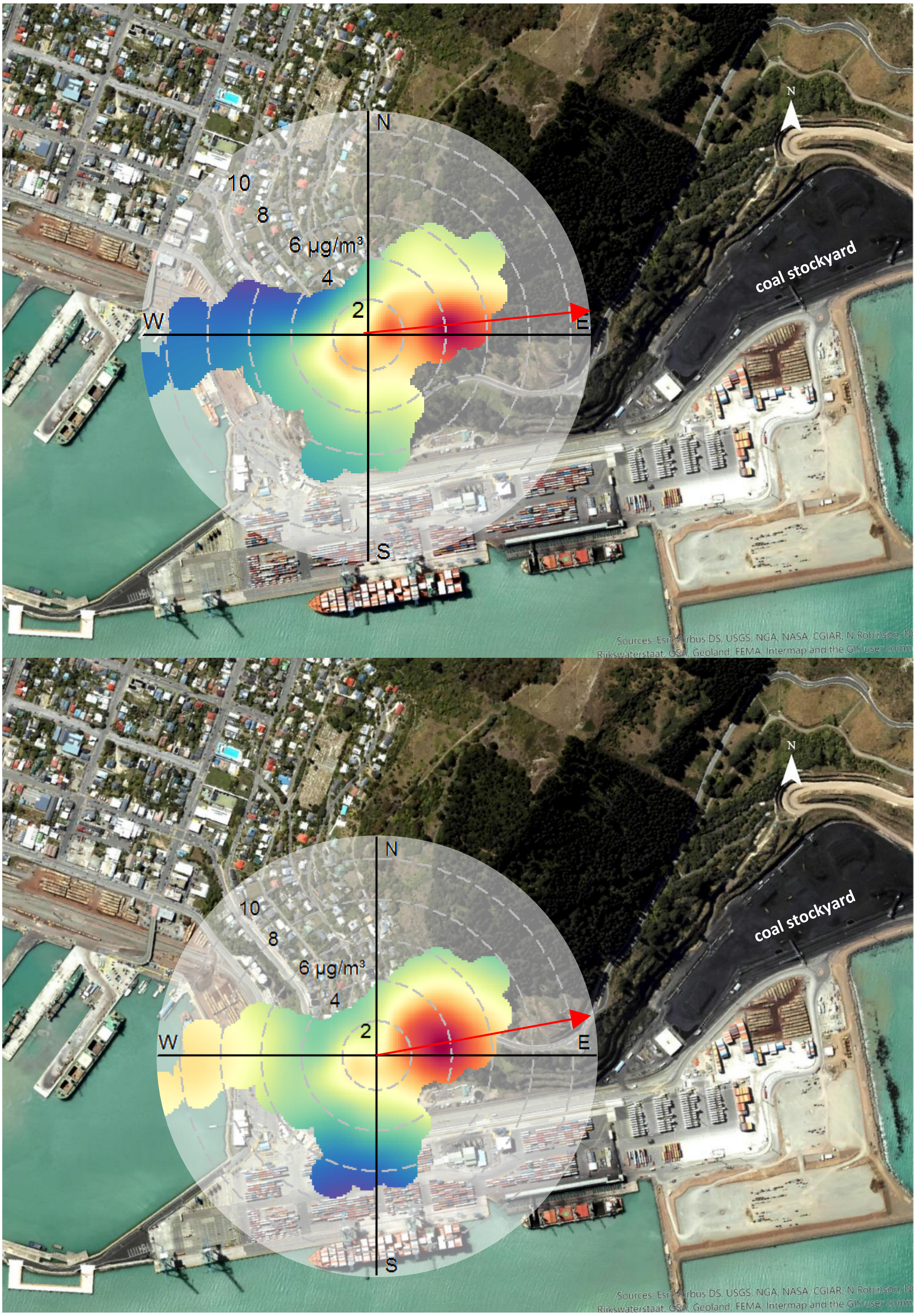

Figure 9.2: Polar plots of peak 1-hour average PM_{10} (top) measured by the Nephelometer at 2 Gilmore Terrace and PM_{10} (bottom) measured by the BAM at 1 Gilmore Terrace.

Figure 9.3: Comparison of polar plots of maximum 1-hour average PM_{10} concentrations for nephelometer monitoring sites

10 Question 10 – Dust associated with Te Awaparahi Bay reclamation

Request

The potential impact of dust discharged from the large unconsolidated area of the Te Awaparahi Bay reclamation is not discussed in any detail. Please consider the impact of this potential source of dust when analysing the relationship between PM_{10} and $PM_{2.5}$ BAM concentrations and wind data.

Response

The Te Awaparahi Bay reclamation is largely completed for now, and earthworks associated with it were not being carried out at the time of the ambient monitoring programme for PM_{10} and $PM_{2.5}$, other than an isolated instance of 1 week where a sea wall was topped up following a storm event.

Dust discharges associated with the reclamation earthworks and transportation of material from Gollans Bay Quarry may impact on residential locations under similar wind conditions to the coal stockyard. However, those discharges are not the subject of this application and dust discharges from those earthworks will have a distinctly different colour from coal dust and are therefore not considered to give rise to a cumulative/additive effect. Accordingly, dust emissions associated with the Te Awaparahi Bay reclamation would not have contributed appreciably to the PM_{10} and $PM_{2.5}$ results of the ambient air quality monitoring programme.

As noted in Section 2, the analysis of non-coal dust deposition did record an impact of the reclamation at deposition monitoring site 6 in the years prior to the ambient PM_{10} and $PM_{2.5}$ monitoring programme commencing. However, those dust deposition impacts have reduced over time as reclamation works have progress and are now largely completed. Overall, the dust emissions associated with Te Awaparahi Bay reclamation do not alter the conclusions reached in the T+T Air Quality Assessment (notably those in Section 5). Figure 4 provides a view of the state of the reclamation at the time of the ambient PM_{10} and $PM_{2.5}$ monitoring programme, showing the stabilised state of the reclamation and the location of the dust deposition monitoring sites.

We note that dust associated with the construction of the reclamation is authorised by resource consent CRC175510 and requires LPC to implement a range of measures to control dust emissions from those works. This includes the uses a water cart to suppress dust from frequently trafficked surfaces.

Figure 4: Aerial image showing the state of the reclamation during the ambient PM_{10} and $PM_{2.5}$ monitoring programme (composite image dated 10 Dec 2020 and 13 January 2021, source LPC).

11 Question 11 – Dust associated with different wind speed conditions

Request

Peak concentrations measured by the nephelometer instruments occur with windspeeds between 2 m/s and 6 m/s. This aligns more with PDP's expectations of the relationship between dust concentrations and windspeed. However, the nephelometer data relationship with wind speed does not align particularly well with that of the BAM. Please explain why this may be the case and discuss the potential implications of this unexpected result on the conclusions reached on human health impacts using the ambient air quality monitoring data.

Response

This matter has been addressed in the response to Question 9 above. In particularly the revised BAM data now aligns with the data from the nephelometers

12 Question 12 – Upwind and downwind analysis of coal stockyard

Request

T+T concluded that the comparison of nephelometer PM_{10} concentrations measured upwind and downwind of the coal stockyard demonstrates that PM_{10} concentrations are about the same, i.e., the coal yard is not the significant source of PM_{10} in the area. The result seems counter intuitive to PDP. Please explore this issue and confirm or revise the relevant conclusions after it has been demonstrated that the nephelometers are responding usefully to coal dust.

Response

Our conclusion regarding this matter is based on PM_{10} concentrations being relatively low, the proportion of coal within the measured PM_{10} concentrations being low, and that marine aerosols (salt) dominates the composition of measured PM_{10} concentrations. Given this our conclusion remains that the coal stockyard is not a significant source of PM_{10} (as described in Section 6.6 of the T+T Air Quality Assessment) on the basis of source apportionment analysis, corroborated through upwind and downwind PM_{10} concentration analysis.

13 Question 13 – Additional source apportionment analysis

Request

The source apportionment monitoring is a very useful add on to the coal stockyard ambient air quality monitoring programme, and PDP consider this provides significant value to the assessment. To extract some additional value out of that data set and to further support the conclusions reached by T+T it is requested that the following data analysis be undertaken, and results presented:

- *An analysis of the meteorological conditions that persisted during the periods in which the source apportionment monitoring indicates a relatively high impact of coal dust;*
- *A comparison of the meteorological conditions which caused peak coal dust impacts for the source apportionment, BAM and nephelometer data;*
- *A comparison of the BAM and nephelometer data for the periods in which the source apportionment monitoring indicates a relatively high impact of coal dust; and*
- *A comparison of the coal dust impact as measured by the source apportionment and dust deposition monitoring.*

Response

With regards to point 1, we have identified the dates associated with the highest 24-hour average contribution of coal in the PM_{10} size fraction – for the purpose of this analysis this was taken to be concentrations of coal dust that were 5 µg/m³ or greater. These dates (listed in Table 13.1) were then reconciled against the hourly average PM_{10} and wind monitoring data, and further filtered to select only those wind directions that could reasonably be associated with the coal stockyard (i.e., 30 °N to 130°N). It should be noted that that these directions are similar to those associated with winds being channelled up the harbour and therefore associated with conditions that would be conducive to a greater contribution of marine aerosols.

The analysis of the hourly PM_{10} data for these dates and when the monitoring site is downwind of the coal stockyard is presented in Figure 13.1 along with the corresponding wind speeds. The data shows a very weak positive relationship with wind speed (R^2 of 0.11), from which no clear conclusion can be drawn. T+T hypothesises that this is because the peak 24-hour average coal derived PM_{10} concentrations are likely to be a function of both wind speed but also the frequency that the monitor was downwind of the coal stock yard.

Points 2 and 3 seek analysis relating to the nephelometer data. It is assumed the interest here stems from the difference in results for the BAM and Nephelometer data presented in the T+T Air Quality Assessment. The analysis presented in Section 9 of this report, presented corrected results and analysis following identification of an incorrect date and time values with the BAM and wind monitoring data. The corrected data now shows good agreement between the BAM and nephelometer instruments. Given this, we do not consider there is a need to provide further analysis associated with the nephelometer data.

With regards to point 4, we do not consider that a meaningful analysis of the source apportionment data and dust deposition data can be made. Our reasoning for this is the dust deposition monitoring is carried out on a 2-weekly or monthly basis, meaning that there is insufficient data available for the for the monitoring period where the two datasets coincide to allow for a robust statistical analysis. Furthermore, as noted in Section 2 of this report, the IAQM (2016) advises that PM_{10} and $PM_{2.5}$ (for which the source apportionment data relate to) are not readily comparable to dust deposition data. Accordingly, further source apportionment monitoring to gather a large dataset is not expected to enable such a comparison to be undertaken.

Table 13.1: Dates when peak 24-hour average coal derived PM_{10} concentrations occurred (contribution 5 µg/m³ or greater)

Date	Peak 24-hour average coal derived PM_{10} concentration (µg/m³)
8/04/2021	12.7
10/04/2021	9.6
26/03/2021	8.8
28/02/2021	7.8
9/04/2021	7.7
18/02/2021	7.6
15/04/2021	7.5
3/04/2021	7.0
19/03/2021	6.9
22/03/2021	6.7
1/04/2021	6.3
14/04/2021	6.2
7/04/2021	6.2
22/04/2021	5.7
21/02/2021	5.7
17/02/2021	5.2
12/04/2021	5.0

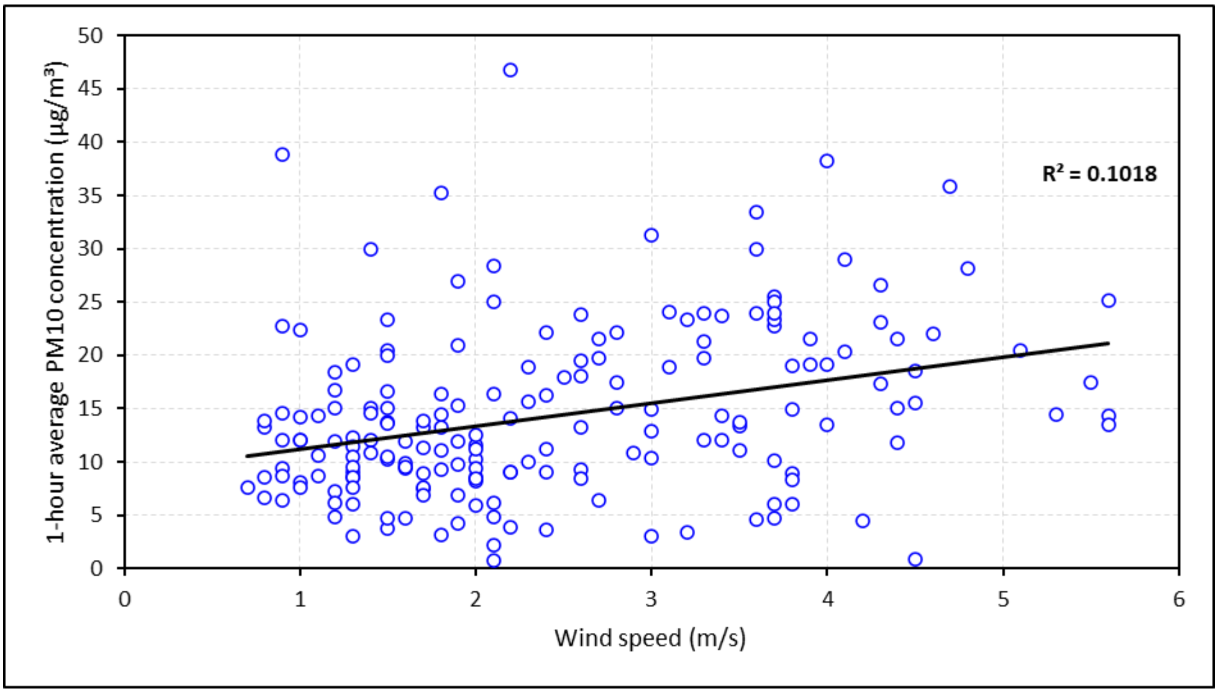

Figure 13.1: Graph showing the relationship of hourly PM_{10} and wind speed for days when there was a peak contribution of coal dust to measured PM_{10} and when winds are from the direction of the coal stockyard.

14 Question 14 – Stockpile shape

Request

Stockpiles have been calculated as generating 38% of the total dust discharged from the stockyard. In regard to current dust management strategies the following mitigation measures are highlighted as important:

- *Height and slope of stockpiles; and*
- *Shape of stockpiles.*

However, no details are provided in the assessment or dust management plan on how the stockpiles are designed or built. PDP consider that the stockpiles should be constructed to minimise the surface area to volume ratio and consideration given to the orientation of the graded slopes of the stockpiles relative to the predominant wind direction. Please revise the assessment and/or dust management plan to include the coal stockpile design criteria and method of building stockpiles to minimise dust emissions. PDP consider that a review of and reference to LPC's coal stock yard operational plan would be very helpful.

Response

LPC advise that based on their coal stockyard operational plan (November 2006) the stockpiles are formed primarily based on:

- export requirements;
- safety considerations (primarily the operation of bulldozers on the piles);
- the size and shape of the coal stockyard; and
- The location of the gantry stacker and rotary reclaimer.

The spatially constrained nature of the site and those parts of the site that can be accessed by the gantry stacker and rotary reclaimer are the primary matters determining stockpile configuration and shape. Given this, the stockpiles are formed in the same general locations, with height and slope based mainly around safety considerations in terms of slope stability.

Cong et al (2012)[15] investigates the effect of aggregate stockpile configuration and layout on dust emissions in an open yard. The key finding of the study is that there is an appreciable benefit in reducing dust emissions associated with flat-topped, oval configuration stockpiles versus those of a conical configuration (as shown in Figure 14.1). In practice, the shape of stockpiles formed by LPC typically achieve the flat-topped oval configuration where those piles are formed using front end loaders and bull dozers.

[15] Cong X C, Yang S L, Cao S Q, Chen Z L, Dai M X, Peng S T, 2012. Effect of aggregate stockpile configuration and layout on dust emissions in an open yard. Applied Mathematical Modelling 36(2012) 5482-5491.

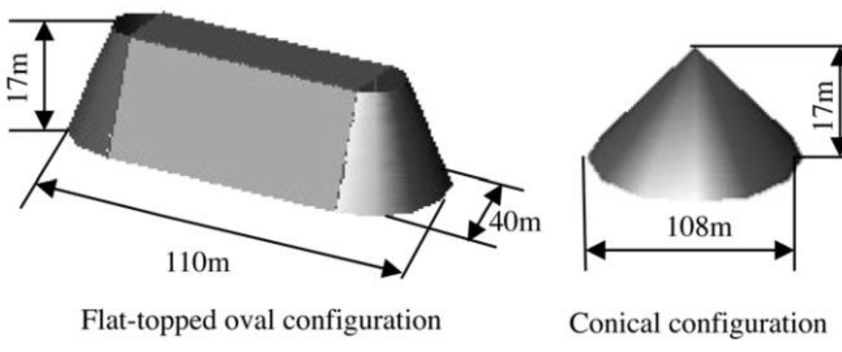

Figure 14.1: Dimension of stockpiles (Cong et al 2012)

Katestone 2011[16] describes that *"there are several common stockpile shapes and this and the stockpile height can have an important effect on the surface area that is predominantly exposed to wind erosion."* Stockpiling can be arranged to minimise the area of the stockpile that is directly exposed to strong winds and to take advantage of the sheltering effect of other stockpiles, terrain or vegetation. In practice, this is achieved by LPC with the relatively small footprint of the LPC coal stockyard and the terrain surrounding the site.

In summary, the coal stock yard is orientated in such a way that it minimises the exposed stockpile surface area to the prevailing east-northeast wind. This is further minimised by the topography, which provides some sheltering from east-northeast winds. The stockpiles are also generally formed as flat top oval shaped piles rather than conical shaped piles as illustrated in Figure 7.3 of the T+T Air Quality Assessment.

Stockpiles on site are frequently formed and consumed as coal is imported ahead of loadout to export ships. For this reason, the shape, height and nature of the stockpiles is constantly changing, although their location is generally the same.

[16] Katestone 2011. NSW Coal Mining Benchmarking Study: International Best Practice Measures to Prevent and/or Minimise Emissions of Particulate Matter from Coal Mining. Prepared for Ofifce of Environment and Heritage – KE1006953.

15 Question 15 – Control of dust from bull dozers

Request

Mitigation Measures (Table 4.1 of the dust management plan (DMP) do not reflect the priority sources suggested by emission calculations (Table 3.1 in main body of the Report). For example, minimal detail is provided on how to reduce emissions from bulldozers which are calculated to generate over half the total dust discharged.

The emission calculations in Table 3.1 also do not appear to reflect the operational experience of dust generation within the coal stockyard with front end loader's practically contributing more than the bulldozers but only accounting for less than 1% of calculated emissions (see also Questions 20 and 21).

Combined Bulldozers and stockpiles have been calculated to discharge over 90% of the dust discharged from the coal stockyard. However, the DMP, as it stands, does not target 90% of the dust mitigation methods on these two sources. The mitigation strategy should focus on the key sources identified.

Please revise the mitigation strategy to reflect the key sources of dust, whether that be as calculated in Table 3.1 or any other effective method of prioritising the magnitude of the respective dust sources.

Response

Katestone 2011[3] notes that there is very little information in the literature on minimising emissions of particulate matter from bulldozers, with emission factors (either USEPA or NPI factors) ranking bulldozer operation as the 3rd most significant source for TSP and PM_{10} emission from coal mining operations. Particulate matter emission occurs because of bulldozer movement and the effect of tracks finely grinding the coal.

Notwithstanding the above, Katestone 2011 describes mitigation options associated with bulldozer operation as including:

- Minimising travel speeds and distances (this is achieved at the coal stockyard through its compact site);
- Stabilising bulldozer travel routes using water (this is achieved by LPC through the combined use of sprinklers and the water cart); and
- Managing coal moisture to ensure coal is sufficiently moist when working (this is achieved through the receipt of coal predominantly from the West Coast that has a high moisture content, the use of sprays bars on the load-in conveyor system, and the use of the sprinklers and water cart with its cannon system to target stockpiles).

Given the above, the key factor for minimising dust emissions from bulldozer operation is the application of water to travel routes and stockpiles. This is the key measure employed by LPC for the site, which targets both wind erosion of dusty material from the stockpiles and from the operation of the bulldozers. Accordingly, we consider that the dust management measures described in the DMP appropriately target these two significant sources.

16 Question 16 – Two-tier management approach

Request

PDP consider the two-tiered (above and below 1.75 million tonnes of coal per annum) mitigation plan a potentially useful approach. The key proposed Tier 2 mitigation actions appear to be introducing the use of fog cannons and using strategically placed nephelometers to provide real-time dust data which will allow proactive dust mitigation to be undertaken. Before agreeing that this plan will be effective, PDP would like to see evidence of the efficacy of fog cannons in reducing coal dust and to have demonstrated the ability of nephelometers to respond to coal dust.

PDP notes that it considers that the results of the trial of the fog cannon should occur as part of this consent application, not at some indeterminant time in the future when coal throughput reaches the trigger value. This would ensure that when throughput reaches the trigger there is no potential for effects. It would also provide LPC with the ability to consider and trial other mitigation measures if the fog cannons do not work as anticipated.

Response

The section 92 question summaries the 2 Tier approach for mitigation correctly, although we note that the use of a watercart would continue to be used to provide water suppression as part of the proposed second tier mitigation.

Fog cannons as a dust control measure is a relatively recent technology (nominally 10 years) but one that has been widely adopted by a variety of industries in both New Zealand and overseas. This includes the likes of quarrying (in particular, the control of emissions in and around processing plants), demolition and construction, stock-piles management and bulk handling activities.

The principle of fog cannons is the generation of a fine water mist spray that improves the ability of the water droplets to interact with suspended dust particles when compared to water sprinkler systems where the droplets are often too large to provide an effective form of suspended dust reduction.

By comparison, the use of the water sprinklers is primarily a means of applying water to a surface to suppress dust emissions from occurring – they are relatively ineffective at removing airborne dust particles. Although less water is used with fog cannons, they will also act to dampen exposed surfaces, helping to suppress dust emissions. Wetting of exposed surfaces will be further achieved with the ongoing use of the watercart.

We have carried out an extensive literature review to better understand the benefits of different dust control strategies for coal handling operations, with a particular focus on fog cannons. In practice there is very little in the way of comprehensive or definitive published articles or guidance on fog cannons for controlling dust (whether from coal or other sources of dust). We consider this is likely to reflect their recent adoption for use in this regard, and we note that there are numerous suppliers of fog cannon equipment that promote their use for managing dust from stockpiles, and coal handling/mining operations. Widely used generic emission factor guidance, such as the Australian National Pollution Inventory[17] (NPI) and the US EPA AP-42 guidance[18], describe the benefit of different measures, particularly the application of water. However, they do not describe the use of fog cannons or fogging sprays as these guidance documents predate the widespread use of this technology.

[17] NPI 2012. National Pollution Inventory – Emission Estimation Technique Manual for Mining – Version 3.1. National Pollutant Inventory. Australian Government – Department of Sustainability, Environment, Water, Population and Communities.
[18] US EPA AP42 Compilation of Air Emission Factors – Chapter 11: Mineral Products Industry.

Notwithstanding the above, our conclusion remains that the proposed trial approach set out in the application for the use of the fog cannons is appropriate for the following reasons:

- LPC advises that it is not expected to be economically viable to procure and implement the fog cannon system ahead of a clear expectation that coal throughput increases to 1.75 million tonnes per annum. Further, LPC advises that it is likely to take a number of years planning to facilitate an increase above 1.75 million tonnes per annum.
- Continuous dust monitoring downwind of the coal stock yard in the direction of the Lyttelton community will continue. While the monitoring will be used to evaluate the efficacy of the fog cannons, it will also be used to enable a pro-active response to changing dust conditions as they arise.
- As discussed in the response above, the use of nephelometers for monitoring of dust emissions from coal handling operations is an appropriate technology and widely used for that purpose.
- The application and proposed conditions envisage the use of a second water cart (providing more frequent water suppression) will be initiated if it is determined that the fog cannon approach is identified as not providing the anticipated benefit.

Notwithstanding the above, as noted in Table 4.2 of the Draft Dust Management Plan, *"in the event that the fog cannons are not used beyond the trial and when coal experts are predicted to exceed 1.75 million tonnes per year, a second water cart will be used in addition to the existing mitigation measures."* When combined with the proposed use of continuous dust monitoring, this provides a significant degree of redundancy and surety that appropriate mitigation can be implemented.

Given the above, we consider that the proposed trial as set out in the proposed conditions is reasonable and the trial does not need to be implemented ahead of reaching the coal through-put trigger.

17 Question 17 – Dust management plan

Request

The DMP appears to have been written as a desk top exercise. There is no obvious input or review from the LPC coal stockyard operators or management or third-party coal management experts who could review and if needed add value to the DMP. PDP request confirmation that the proposed DMP has considered and where appropriate incorporated the internally (LPC) and externally available expertise and experience in coal stockyard management.

Response

The DMP was prepared by air quality experts at T+T with extensive experience in the mechanisms for dust generation and control (including from coal handling operations). It was also informed through several visits to the coal stockyard to consider on-site activities and discuss operations and measures with the coal stockyard operator. The DMP was then reviewed with input from LPC coal stockyard operator and wider project team prior to its finalisation.

The activity, mechanisms for dust generation and measures used to control dust are not appreciably different from other dust generating activities, such as quarries, mines, and aggregate handling and processing facilities. In particular, emissions can occur from wind erosion of exposed surfaces and stockpiles and from the propagation of dust from machinery activity (front-end loaders, bulldozers, conveyor systems etc). Similarly, control measures typically employed are also largely the same (predominately the application of water to suppress emissions).

18 Question 18 – Emission calculations and NZ specific coal data

Request

It appears that almost no New Zealand specific coal specifications has been used as input into the dust emission calculations. One coal analysis report from 2011 is referenced in the report. In most cases it appears that USEPA defaults have been used when defining the size distribution and moisture content of the coal handled at the LPC coal stock yard. Please obtain and review the relevant coal specification reports for coal handled at Lyttelton and comment on how that data aligns with (or otherwise) the default values provided in the USEPA default. If the New Zealand data is significantly different to the USEPA default values, please comment on the potential implications of this difference on the results of the emission calculations and the conclusions based on these.

Response

T+T confirms specific coal specification data was used and we have been advised by LPC that those specifications do not vary significantly. In particular, the following values were used:

- A silt content of 8.8%
- A moisture content of 10.5%

These values were derived from a weighted average of measured values for the Stockton and Gray Coalfields mines where the coal is largely sourced from. This is documented in Table 2.3 of Beca 2009[19]. LPC confirmed that the moisture and silt content values have not varied significantly in the intervening period.

Notwithstanding the above, the modelling did not seek to quantify ambient TSP, PM_{10} or $PM_{2.5}$ concentrations, and its purpose was simply to inform the location of ambient monitoring and spatial patterns of impacts. Given this, it is not necessary to have specific coal values to inform the emission calculations for the dispersion model, as doing so would not alter the outcomes derived from the modelling. We note that Section 3.4 of the T+T Air Quality Assessment describes:

> *"… dispersion modelling has not been used as the primary basis for the assessment of LPC's coal stockyard, given it is an existing activity and good monitoring data is available to directly quantify the effects associated with the activity. However, dispersion modelling has been used to better understand the spatial pattern of impacts of the activity and to guide the location for ambient monitoring sites…"*

[19] Beca 2009. Coal Stockyard Expansion – Assessment of Effects of Discharges to Air. Report prepared by Beca Infrastructure for Lyttelton Port Company Limited.

19 Question 19 – Dust from unpaved surfaces

Request

In similar bulk landing facilities (like quarries) the action of machine and vehicle wheels on unpaved surfaces is often a key source of dust emissions. The impact of the front-end loaders travelling over coal covered routes dust does not appear to be included in the calculations of dust emissions.

During the site visit the coal stockyard manager indicated that the majority of dust emissions during the formation or loadout of coal stockpiles resulted from front-end loaders rather than bulldozers, especially when particular travel path has become well trafficked.

Please consider, and where needed include, the impact of dust emissions generated by the wheeled actions of front-end loaders during coal load-in or coal load-out.

Response

Please refer to the response provided to Question 20 that also addresses this question.

20 Question 20 – Relative size of each source of dust

Request

Table 3.1 in the Report provides a prioritised list of dust sources which are based on the emission calculations detailed in Appendix B. The order of sources provided in Table 3.1 does not align well with the observations made by T+T staff nor with the experience of LPC staff as noted in the Report. For example, PDP find it counter intuitive that despite the action of front-end loader wheels on unpaved surfaces and the distance front end loaders are likely to travel compared to bulldozers, bulldozers produce 25 times more dust than front end loaders. The priority order of dust sources appears to be based solely on a desktop assessment which has not been subject to any qualitative or quantitative ground truthing.

PDP request that LPC attempt (as far as practical) to ground truth at least the relative size of each of the dust sources listed in Table 3.1. This task could be completed by methods including but not limited to:

- *Consultant observations;*
- *Coal Stockyard staff observations;*
- *Boundary monitoring during similar wind conditions (NE) but during different stockyard dust generating activities including but not limited to;*
  - *Coal load in;*
  - *Coal load out;*
  - *Coal stockpile building; and*
  - *No coal moving activity - but stockpiles present.*

Response

The relative scale of different sources of coal dust was summarised in Section 3.4 of the T+T Air Quality Assessment with reference to the emission calculations (Appendix A) and dispersion modelling (Appendix E). The modelling in of itself did not seek to precisely quantify the likely levels of TSP, PM_{10} or $PM_{2.5}$ in the receiving environment, but instead sought to identify the location for ambient monitoring and spatial pattern of impacts. In this regard the modelling fulfilled that purpose. Because the modelling did not seek to quantify ambient PM_{10} or $PM_{2.5}$ concentrations, it is unnecessary to precisely quantify the proportion of emissions from different sources and in this regard, we do not consider that “ground truthing” the relative size of each dust source is necessary to understand the potential effects of the discharge from the site.

Notwithstanding the above, we have re-examined the emission rates used as input to the dispersion model. Emissions associated with drop actions of coal from the use of the front-end loaders (FEL) were calculated and included in the dispersion modelling. However, upon review, separate factors could have been used that describe dust emissions generated by the wheel action of the front-end loaders within the coal stockyard. In particular, NPI or US EPA AP-42 factors (which are the same), provides emission factors for the operation of front-end loaders. In applying these factors, we have calculated a new relative breakdown in coal dust emission rates to that given in Table 3.1 of the T+T Air Quality Assessment, which is presented as in Table 20.1.

Table 20.1 shows the bulldozers remain a significant *calculated* source based on the use of published emission factors. In practice, the emissions from the front-end loader movements in the coal stock yard will occur under the same meteorological conditions and within the same geographic footprint as the operation of the bulldozers. Accordingly, we consider the conclusions reached from analysis of the results of the modelling in terms of its purpose (location for ambient monitoring and spatial pattern of impacts) will be unaffected. In particular, Section 5.6 and 6.3.1 of the T+T Air Quality Assessment, where the following is stated:

> *"The spatial pattern of coal dust impacts has been analysed using existing coal dust deposition data and dispersion modelling. This indicates the closest residential area of Lyttelton around Gilmore Terrace is the most impacted sensitive location. However, there are unlikely to have been significant coal dust impacts beyond the nearest residences."*
>
> *"The primary location for the monitoring [regarding PM_{10}, $PM_{2.5}$ and source apportionment] was determined using dispersion modelling of emissions from the coal stockyard. From this it was identified that a location off Gilmore Terrace and just above the Timeball Station would be suitable."*

Table 20.1: Proportion of annual average total suspended particulate emissions from various on-site activities.

Source	Activity	Proportion of total suspended particulate from activities	
		Front end loader use not included in pile forming and tracking (as presented in Table 3.1 of the AQA)	Including front end loader use in pile forming and tracking
FEL movement	Pile forming	-	48%
Bulldozing	Pile forming	54%	28%
Stockpile	Wind erosion	38%	20%
Conveyor Transfers	Transfers	4%	2%
Gantry stacker	Load in	1%	1%
FEL	Load in	1%	< 0.5 %
FEL	Load out	1%	< 0.5 %
Conveyors	Transfers	1%	< 0.5 %
Bucket reclaimer	Load out	< 0.5 %	< 0.5 %

21 Question by CRC in relation to coastal water quality and ecology

21.1 Question i – Marine avifauna respiratory effects

Request

The report on the assessment of effects on marine avifauna deals with the potential impacts of the coal dust on food supply and foraging ability and mortalities and disturbance associated with machinery and coal ship movements. In the report it acknowledges that it does not address the issue of the health of birds as that is a physiological matter and outside the report writer's area of expertise. Please provide an assessment of the potential effect of the coal dust on the respiratory health of the marine avifauna.

Response

From a literature review, we are not aware of any published study that considers the respiratory effects of coal dust on local marine avifauna. Several studies have been undertaken to study the effects of gaseous pollutants on avian health (Sanderfoot and Holloway 2017[20]) and found that ozone, nitrogen dioxide and carbon monoxide can affect the respiratory systems of birds. However, the evidence for PM is limited and effects have been limited to fine particles, less than 3 µm in diameter. Larger particles appear to deposit in the upper airways and do not penetrate in the lower respiratory system. These findings relate to urban PM rather than coal dust specifically.

Notwithstanding this, we note that the United States Environmental Protection Agency (US EPA) secondary standards for PM_{10} (150 µg/m³ as a 24-hour average) have not changed since 2012[21] and are considered by the US EPA to protect against ecological and welfare considerations. In particular, US EPA Federal Register (Vol. 78, No10 – Part II, 2013) states the following:

> *"With regard to the secondary PM standards, the Administrator is retaining the current suite of secondary PM standards, except for a change to the form of the annual $PM_{2.5}$ standard. Specifically, the EPA is retaining the current secondary 24-hour $PM_{2.5}$ and PM_{10} standards, and is revising only the form of the secondary annual $PM_{2.5}$ standard to remove the option for spatial averaging consistent with this change to the primary annual $PM_{2.5}$ standard. This suite of secondary standards addresses PM-related non- visibility welfare effects including ecological effects, effects on materials, and climate impacts."*

Additionally, the US EPA Integrated Science Assessment (ISA)[22] found that there are ecological effects with components of particulate matter, such as metals and organics, but not mass of particulate matter. However, the assessments – scientific, policy and ultimately political – conclude that the current standards protect against these effects. That is, the air quality standard for the protection of human health will also be protective of ecological effects.

In the context of New Zealand, it is note-worthy that the National Environmental Standard for Air Quality (NESAQ) has a PM_{10} standard (50 µg/m³ as a 24-hour average) that is one third of the US EPA secondary standard for PM_{10}.

With regard to the LPC Coal Stockyard, as part of the ambient monitoring programme, measurements of PM_{10} were carried out using a nephelometer at the Coal Stockyard's water treatment plant. This provides data that is representative of a location very close to the coal stockyard and is likely to be representative of exposure levels for marine avifauna at this location. The results of this monitoring and comparison with the concentrations measured at 1 Gilmore

[20] Olivia V Sanderfoot and Tracey Holloway 2017 Environ. Res. Lett. 12 083002

[21] Although two reviews have been carried out over the period since 2012

[22] U.S. EPA. Integrated Science Assessment (ISA) for Particulate Matter (Final Report, Dec 2009). U.S. Environmental Protection Agency, Washington, DC, EPA/600/R-08/139F, 2009.

Terrace (the most exposed residential location) are presented in Figure 21.1. This figure shows concentrations that are very similar between the two sites, indicating relatively little impact of PM_{10} concentration even when close to the coal stockyard. It also clearly illustrates concentrations that are well below both the US EPA Secondary standard and the NESAQ for PM_{10}.

Given the above context, it can be concluded that PM_{10} discharges from the coal stockyard are unlikely to give rise to significant respiratory effects of marine avifauna.

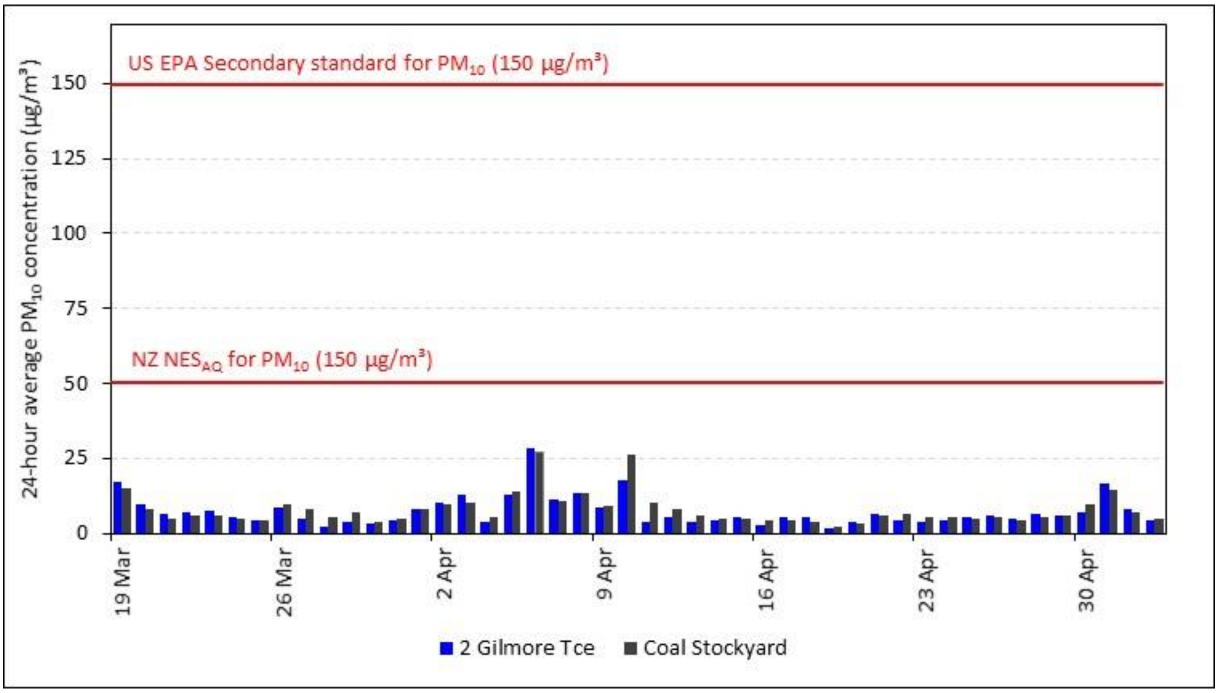

Figure 21.1: Comparison of measured PM_{10} concentrations during 2021 monitoirng study at Gilmore Terrace and the Coal Stockyard and comparison with the NZ NESAQ and US EPA Secondary Standard for PM_{10}.

22 Questions by CRC in relation to terrestrial ecology impacts

22.1 Question i – Port traffic and climate

Request

Please consider increased port traffic/coal volumes in future and or climate related exacerbations to depositional rates/amounts – i.e., if becomes windier / drier.

Response

Dust deposition data that has been provided with the T+T Air Quality Assessment and used to inform the terrestrial assessment has been collected over a long duration (since 2008). Consequently, it provides a measure of actual impacts under a very wide range of wind conditions that could propagate dust from the site. Over this period, both El Nino and La Nina climatic conditions prevailed, that latter of which giving rise to more frequent northeasterly wind conditions that have a greater potential to propagate dust emissions due to the alignment of the harbour and exposure of the coal stockyard to winds from this direction.

From a meteorological perspective, it is T+T's opinion that the long-term monitoring dataset encapsulates prolonged periods of strong, dry wind conditions and those that are more frequently from the northeast. Given this, we consider these conditions reasonable encapsulate the conditions that might be anticipated by climate change over the proposed term of the consent and no change is required.

With regard to coal volumes, we note that the coal deposition monitoring data also encapsulates coal volumes through the coal stockyard that are higher than those for which consent is currently sought.

22.2 Question ii – Environmental limit

Request

Please consider having an environmental limit reflecting this (1 g/m²/day) on a gauge located in north of the site, or some other environmental monitoring indicator.

Response

This question is in the context of a statement by the CRC's Senior Ecologist, who notes:

> *"coal dust may affect plants if in excess of 1.0 g/m²/day. Effects have been assessed taking an impact management approach, which entails dust control measures and monitoring".*

The s92 request does not describe the literature source as basis for this deposition rate as being the threshold at which effects on plants may occur.

Notwithstanding the above, we note that a deposition rate of 1 g/m³/30-days corresponds to a deposition rate of 30 g/m³/30-days when expressed in units that relate to the monitoring method. As shown in Figure 1.2 of the assessment, the highest deposition rate measured between 2008 and 2020 at the most impacted on-site monitoring locations (sites 15 and 16) were much lower than this deposition rate, with a maximum recorded deposition rate of 19 g/m²/30-days. Literature referenced in the Terrestrial Ecological Report indicates that 1.0 g/m^2/day of prolonged dust deposition is needed to start affecting physiological processes in plants. As outlined above, monitoring data indicates that historically dust deposition has been much lower than this, which is evident by no dust deposition seen on / within surrounding vegetation or surrounding vegetation being visually impacted. Therefore, setting a threshold at 1.0 g/m^2/day is not warranted.

22.3 Question iii – Environmental limit

Request

Given that the deposition of coal dust is not likely to be linear (i.e., that there are discrete events of coal dust deposition) please explain how a monthly depositional rate is the most effective means to monitor dust deposition.

Response

Deposition monitoring follows a standard methodology where dust accumulation of a 30-day period is collected, before the same is removed for laboratory analysis. In some instances, this period can be shortened to 15 -days (as is the case for the most impacted residential monitoring sites – sites 10, 11, and 13), but the results are still representative of the accumulation over a moderately long period of time.

T+T is not aware of the use of dust deposition gauges, where samples are collected on a daily basis as inferred by the question from CRC. Furthermore, our assessment of terrestrial ecological report concludes that there is no observable effect and the current dust management measures appear to be effective and when combined to further control measures as outlined in the Air Quality Report the overall ecological effect will be very low or low. This conclusion doesn't warrant any further monitoring or monitoring methodology than what is already proposed as it is deemed effective based on historic information / data.

22.4 Question iv – Environmental limit

Request

A monitoring gauge site should be established to best capture potential effects on high value indigenous vegetation and habitats (i.e., north of site near current gauge site 2, 3, 4) with 1.0 g/m^2/day limit trigger.

Response

A deposition rate of 1 g/m^2/day corresponds to 30 g/m^2/30-days, when expressed in units that more accurately reflect the monitoring method (i.e., samples are collected over a 30-day period). As shown in Figure 1.2 of the assessment, the highest deposition rate measured between 2008 and 2020 at the most impacted on-site monitoring locations (sites 15 and 16) were much lower than this deposition rate, with a maximum recorded deposition rate of 19 g/m^2/30-days.

Given this and the proposed dust mitigation measures, it is considered very unlikely that deposition rates in the future would approach 30 g/m^2/30-days at the most impacted on-site monitoring site. Literature referenced in the Terrestrial Ecological Report indicates that 1.0 g/m^2/day of prolonged dust deposition is needed to start affecting physiological processes in plants. As outlined above, monitoring data indicates that historically dust deposition has been much lower than this, which is evident by no dust deposition seen on / within surrounding vegetation or surrounding vegetation being visually impacted. Therefore, setting a threshold at 1.0 g/m^2/day is not warranted.

23 Closing

Our responses refer to information provided in the consent application and address the questions raised in the section 92 request. We trust that there is now sufficient information available for you to continue processing the application. Please do not hesitate to contact Richard Chilton if you require further clarification of any aspects of this letter. We look forward to receiving draft conditions for our review and comment in due course.

24 Applicability

This report has been prepared for the exclusive use of our client Lyttelton Port Company Limited, with respect to the particular brief given to us and it may not be relied upon in other contexts or for any other purpose, or by any person other than our client, without our prior written agreement.

We understand and agree that our client will submit this report as part of an application for resource consent and that Canterbury Regional Council as the consenting authority will use this report for the purpose of assessing that application.

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