Dispersion Modeling of Ethanedinitrile Airborne Concentrations Associated with Timber Fumigation at the Port of Tauranga, New Zealand

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1.0 Executive Summary

Methyl bromide is the fumigant of choice at this time for the fumigation of forest products (especially logs) in New Zealand. With the phasing out of methyl bromide, however, there is a need for an alternative fumigant. Ethanedinitrile (EDN) is an alternative that could replace methyl bromide, which could meet the fumigation needs without the adverse effects on the ozone layer that is associated with methyl bromide. This report shows modeled concentrations of EDN using the Port of Tauranga as an example. The calendar year 2019 was used to represent current application frequencies, locations, time of day, and the volumes of fumigation for log stacks and ship fumigation. Figure E-1 shows the Port of Tauranga and the fumigation areas that were modeled in this assessment. Table E-1 summarizes the health endpoint associated with EDN:

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>TEL air bystanders</td>
<td>0.034 ppm</td>
</tr>
<tr>
<td>WES – TWA (8 hours)</td>
<td>3 ppm with a 5 ppm ceiling level</td>
</tr>
<tr>
<td>AEGL-1 (1 hour)</td>
<td>2 ppm</td>
</tr>
<tr>
<td>AEGL-1 (1 hour)</td>
<td>2.5 ppm</td>
</tr>
</tbody>
</table>

"The AEGL-1 is the airborne concentration, ppm or mg/m³ of a substance above which it is predicted that the general population, including “susceptible” but excluding “hypersusceptible” individuals could experience notable discomfort, irritation, or other asymptomatic non-sensory effects. However, the effects are not disabling and are transient and reversible upon cessation of exposure. "

In this report, modeling was conducted on an hourly basis with model output for 1-hour, 8-hour, and 24 hours. The 1-hour and 24-hour standards apply to the general public, and the 1-hour standard applies to bystanders not associated with fumigation applications. All concentrations at the port boundary are within the 1-hour and 24-hour regulatory requirements. The WES-8-hour TWA applies to worker exposures. As shown in Appendix F based on the combined log stacks and ship scenario, the 8-hour WES-TWA standard for worker exposure is being met and the 1-hour endpoint is met at all locations beyond the immediate fumigation locations. For the log stacks only and ships only scenario, the impacts would be less. Although the modeling is based on hourly meteorological data, which is not suitable to estimate 10-minute modeled concentrations, it can be demonstrated that the AEGL-1 (10-minute standard) also will be achieved based on field data collected by Draslovka relative to a proposed bystander buffer distance of 30 m.

Table E-2 shows the current use of methyl bromide at the Port of Tauranga based on the calendar year 2019. As shown, the heaviest use of fumigant is in the fall, with the lightest use in the winter.

<table>
<thead>
<tr>
<th>Season</th>
<th>Months</th>
<th>Amount of Methyl Bromide Used (kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Summer</td>
<td>December, January, February</td>
<td>44,314</td>
</tr>
<tr>
<td>Fall</td>
<td>March, April, May</td>
<td>66,091</td>
</tr>
<tr>
<td>Winter</td>
<td>June, July, August</td>
<td>33,713</td>
</tr>
<tr>
<td>Spring</td>
<td>September, October, and November</td>
<td>36,040</td>
</tr>
</tbody>
</table>

This modeling analysis complements the modeling produced by Todoroski Air Sciences for Worksafe New Zealand. Table E-3 provides a summary of the methods used in this modeling analysis in comparison to those used in the Todoroski Air Sciences analysis. The analysis in this report uses Monte Carlo sampling methods to represent port operations and shows percentiles of...
exposure up to the 100th percentile. The goal of this modeling is to represent port operations as directly as possible using the calendar year 2019 as the basis for venting fumigants as a function of the range in time of day, range in application size, and the treatment of multiple applications. A range of percentiles in addition including the 100th percentile is provided for perspective by toxicological review.

The modeling conducted by Todoroski Air Sciences is focused on representing worst-case exposures (such as very large sources, nighttime operations for log stacks, and other conservative assumptions). When both analyses are viewed in a complementary fashion, reviewers are provided with a more complete perspective on exposures, including the likelihood of exposures relative to toxicological endpoints and relative to the safety margins incorporated into the health standards. For example, based on Table 20 in this report, the highest boundary 1-hour concentration (100th percentile) is shown to be 0.67 ppm (672 ppb), and the 99th percentile is 0.06 ppm (60.0 ppb), and the 98th percentile is 0.03 ppm (26.3 ppb). The worst-case 100th percentile event by definition is rare (in this case 1 hour every 3 years) and have a high potential to model artifacts / outliers and amplifying the resultant figure. By having both perspectives, regulatory authorities have a more complete presentation of the actual exposures likely to be encountered at and near the port. Interpretation of the modeling results by a toxicologist will provide the needed perspective to help interpret the modeling results relative to both the standards and the safety margins incorporated into the standards (refer to Pemperton, 2020).

Figure E-1 shows describe the locations where fumigation occurs at the Port of Tauranga. Figure E-2 shows the number of applications by hour of day and by season.

This also implicitly assumes that a port bystander would be standing stationary at the maximum location for a full hour when the once in three year worst-case event occurs. The joint probability of the confluence of these two events is quite small.
Figure E-1: Port of Tauranga Fumigation Areas (Page 1 of 2)
Figure E-1: Port of Tauranga Fumigation Areas (Page 2 of 2)
Figure E-2: Number of Applications by Hour of Day by Season

Number of Methyl Bromide Venting Events by Hour of Day for Each Season at the Tauranga Port in New Zealand during 2019

- Summer Applications
- Fall Applications
- Winter Applications
- Spring Applications

<table>
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<th>Hour of Day</th>
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<th>Winter</th>
<th>Spring</th>
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Dispersion Modeling of Ethanedinitrile Airborne Concentrations Associated with Timber Fumigation at the Port of Tauranga, New Zealand
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<th>Todoroski Air Sciences</th>
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<tr>
<td>Model</td>
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<td>CALPUFF 7.2.1</td>
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<tr>
<td>Averaging units</td>
<td>Hourly</td>
<td>Hour, sub-hourly</td>
</tr>
<tr>
<td>Venting scenarios</td>
<td>Monte Carlo sampling per Port of Tauranga 2019 operational data</td>
<td>Assumed scenarios</td>
</tr>
<tr>
<td>Assumed concentrations at venting</td>
<td>500, 700, and 1,000 ppm</td>
<td>500, 700, and 1,000 ppm</td>
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<td>Meteorological data</td>
<td>Regional council 2014 – 2016 CALMET ready data</td>
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<tr>
<td>Maximum number of log stack rows</td>
<td>22</td>
<td>32</td>
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<tr>
<td>Hours of the day with venting log stacks</td>
<td>Based on port operational data</td>
<td>All hours</td>
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<td>Ship venting</td>
<td>Nighttime operations based on port operational data</td>
<td>All hours</td>
</tr>
<tr>
<td>Initial vertical dispersion log stacks</td>
<td>2.8 m</td>
<td>1 m</td>
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Recently an expert panel has been convened by the New Zealand Environmental Protection Agency to help guide similar modelling for methyl bromide and ideally to standardize modeling approaches for forest product fumigation in New Zealand. This process has not been completed. To the extent possible, however, the modeling methods used in this report are consistent with the assumptions shown in the expert panel’s joint statement issued on January 30, 2020 (refer to Appendix A). The expert panel completes its work later this Autumn.

The dispersion modeling results for the boundary receptor tables were based on two types of distributions: (1) based on all hours, and (2) limited to only hours with active ventilation at the port. The former more realistically accounts for the frequency of actual exposure at each location on a long-term basis, while the latter serves as a more conservative approach. Both types of distributions are shown in the tables in report. Distributions in the range of the 95th percentile or higher are typically used for regulatory decisions, with the caution that for the upper extreme percentiles, such as the 99th to 100th percentiles, unrealistic model artifacts are more likely to be present. Particularly when the frequency of concentrations entering the uncertainty margins established for TEL’s and AEGL standards are interpreted by a toxicology expert, sufficient context can be provided on expected health effects associated with the upper percentiles, including entering the safety margin should the need arise.

Based on 1,000 ppm EDN concentrations under the tarp at the start of venting, and assuming all log stack emissions are released in the first hour and the ship ventilation releases occur over two hours, all modeled concentrations at the port boundary were less than 2 ppm based on 1-hour averaging, and all were less than the 0.034 ppm standard as applicable to 24-hour bystander exposures. Onsite bystanders also will be within the applicable standards, especially based on Draslovka’s planned bystander buffer zone of 30 m. All modeled concentrations also were below the 1-hour and 24-hour endpoints at the port boundary when basing the distributions on only periods where some active venting associated with either log stacks or ships was in progress at the port (when non-zero modeled concentrations were shown within the port boundary set of receptors).

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3 These assumptions apply to the 500, 700, and 1000 ppm concentration scenarios.
4 These receptors are those within the port boundary at the Port of Tauranga.
For worker exposure (as shown in Appendix F) isopleth maps provide a close-up of the port area to show the maximum impacts for the 1-hour, 8-hour average, and 24-hour based on the combined log stacks and ships scenario. These results are also presented in Figures E-3 through E-5 for the 1-hour, 8-hour, and 24-hour averaging periods, respectively, for the location with the highest impacts (log stack areas) based on the 100th percentile as a bounding limit. The maximum concentrations at 20 and 30 m downwind of the fumigation areas are identified based on the combination ships and log stacks scenario (the highest impact scenario). Appendix F (Figures F-4 through F-6) show a close-up of modeled concentrations near the ship fumigation berth areas also based on the 100th percentile distributions. Regulatory limits should be based on a percentile less than the 100th percentile i.e. rely on concentrations within the range of the 95th to 98th percentile, to avoid the potential for model artifacts. In this case, the bounding limit was plotted for two reasons:

1. To more clearly display the results (the isopleth analyses for the lower percentiles were not as well ordered because of the relatively low frequency of active venting periods, and

2. The results show for each averaging time that the health endpoints listed in table E-1 were met, even at the 100th percentile. If it had been necessary, model plots could have been created for the 98th, and 99th percentiles as well by modeling an alternative receptor grid in the near-field. The modeling of near-field effects for specific sizes of isolated log stacks as a function of size was not needed at this time based on review of the composite results. Note that if necessary in the future that ship only distributions also could be created, but this would require longer-term Monte Carlo simulation to create stable distributions for these low frequency events.
Figure E-3: Close-Up Isopleth Analysis of Maximum Impact Area of 1-Hour Averaging Based on the Combined Ship and Log Stack Sources (ppm)

Note: the health endpoint of 2 ppm is not shown beyond the immediate application area. The maximum concentration 20 m downwind of fumigation is 1.55 ppm and 1.22 ppm at 30 m. The corresponding concentrations based on 500 ppm or 700 ppm at ventilation would be 50 percent and 70 percent, respectively of the 1,000 ppm results shown here.

5
Figure E-4: Close-Up Isopleth Analysis of Maximum Impact Area for 8-Hour Averaging Based on the Combined Ship and Log Stack Sources (ppm)

Note: the health endpoint of 3 ppm is not shown beyond the immediate application area. The maximum concentration 20 m downwind of fumigation is 0.19 ppm and 0.16 ppm at 30 m. The corresponding concentrations based on 500 ppm or 700 ppm at ventilation would be 50 percent and 70 percent, respectively of the 1,000 ppm results shown here.
Figure E-5: Close-Up Isopleth Analysis of Maximum Impact Area for 24-Hour Averaging Based on the Combined Ship and Log Stack Sources (ppm)

Note: the health endpoint of 0.034 ppm is applicable to locations at and beyond the fence line. The maximum concentration 20 m downwind of fumigation is 0.13 ppm and 0.09 ppm at 30 m. The corresponding concentrations based on 500 ppm or 700 ppm at ventilation would be 50 percent and 70 percent, respectively of the 1000 ppm results shown here. The maximum distance to the 0.034 ppm is 48 m.
Table E-4 presents a summary of the modeled concentrations at the port boundary using distributions based only on hours when there was active ventilation in progress at the port. Table E-5 presents a summary of the modeled concentrations at the port boundary using distributions based on all hours, i.e. including all hours over the three-year period, including hours when active ventilation was not in progress. Table E-4 is a more conservative representation, while Table E-5 shows at each location that actual distribution of concentrations over a long-term period of time. As shown in Table E-5, for example, because there are more hours with zero concentrations in the 1-hour distributions based on all hours, the percentiles lower than the 100th percentile show higher 98th and 99th percentiles for 24-hour than 1-hour values.

Table E-6 through E-8 summarize modeled concentrations at 20 and 30 m from the maximum exposed area based on the combined ships and log stack scenario based on 1000 ppm at ventilation and the 100th percentile based on the 100th, 99th, and 98th percentiles.
Table E-4: Summary of Modeled Concentrations at the Port Boundary Based Only on Hours with Active Ventilation in Progress at the Port of Tauranga

*(note that for presentation purposes the units are ppb)*

<table>
<thead>
<tr>
<th>Maximum concentration at the port boundary (20 or 30 m) 98th percentile</th>
<th>1-hour log stack</th>
<th>24-hour log stack</th>
<th>1-hour log stack and shiphold</th>
<th>24-hour log stack and shiphold</th>
</tr>
</thead>
<tbody>
<tr>
<td>Under the tarpaulin endpoint</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>500</td>
<td>5.56473</td>
<td>1.38857</td>
<td>13.13007</td>
<td>1.96744</td>
</tr>
<tr>
<td>700</td>
<td>7.79062</td>
<td>1.944</td>
<td>18.38209</td>
<td>2.75441</td>
</tr>
<tr>
<td>1000</td>
<td>11.12946</td>
<td>2.77714</td>
<td>26.26013</td>
<td>3.93487</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Maximum concentration at the port boundary (20 or 30 m) 99th percentile</th>
<th>1-hour log stack</th>
<th>24-hour log stack</th>
<th>1-hour log stack and shiphold</th>
<th>24-hour log stack and shiphold</th>
</tr>
</thead>
<tbody>
<tr>
<td>Under the tarpaulin endpoint</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>500</td>
<td>11.80246</td>
<td>1.69773</td>
<td>29.98013</td>
<td>6.63826</td>
</tr>
<tr>
<td>700</td>
<td>16.523244</td>
<td>2.37682</td>
<td>41.97218</td>
<td>9.29356</td>
</tr>
<tr>
<td>1000</td>
<td>23.60491</td>
<td>3.39546</td>
<td>59.96025</td>
<td>13.27652</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Maximum concentration at the port boundary (20 or 30 m) 100th percentile</th>
<th>1-hour log stack</th>
<th>24-hour log stack</th>
<th>1-hour log stack and shiphold</th>
<th>24-hour log stack and shiphold</th>
</tr>
</thead>
<tbody>
<tr>
<td>Under the tarpaulin endpoint</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>500</td>
<td>125.49015</td>
<td>5.23069</td>
<td>336.41287</td>
<td>21.49844</td>
</tr>
<tr>
<td>700</td>
<td>175.6862</td>
<td>7.32297</td>
<td>470.97802</td>
<td>30.09781</td>
</tr>
<tr>
<td>1000</td>
<td>250.58029</td>
<td>10.46138</td>
<td>672.82574</td>
<td>42.99687</td>
</tr>
</tbody>
</table>

Five significant figures have been used to show lower percentiles
Table E-5: Summary of Modeled Concentrations at the Port Boundary Based on All Hours

(Note that for presentation purposes the units are ppb)

<table>
<thead>
<tr>
<th>Maximum concentration at the port boundary 98th percentile</th>
</tr>
</thead>
<tbody>
<tr>
<td>Under the tarpaulin endpoint</td>
</tr>
<tr>
<td>-----------------------------------------------------------</td>
</tr>
<tr>
<td>500</td>
</tr>
<tr>
<td>700</td>
</tr>
<tr>
<td>1000</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Maximum concentration at the port boundary 99th percentile</th>
</tr>
</thead>
<tbody>
<tr>
<td>Under the tarpaulin endpoint</td>
</tr>
<tr>
<td>-----------------------------------------------------------</td>
</tr>
<tr>
<td>500</td>
</tr>
<tr>
<td>700</td>
</tr>
<tr>
<td>1000</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Maximum concentration at the port boundary 100th percentile</th>
</tr>
</thead>
<tbody>
<tr>
<td>Under the tarpaulin endpoint</td>
</tr>
<tr>
<td>-----------------------------------------------------------</td>
</tr>
<tr>
<td>500</td>
</tr>
<tr>
<td>700</td>
</tr>
<tr>
<td>1000</td>
</tr>
</tbody>
</table>

Five significant figures have been used to show lower percentiles
Table E-6: Summary of Maximum Modeled Concentrations Downwind of Fumigated Source Areas Considering Log Stacks and Ships at 20 m and 30 m Downwind Based on 1,000 ppm at Time of Ventilation With Distributions Based on All Hours

<table>
<thead>
<tr>
<th>Distance from Log Piles</th>
<th>1-hour averaging</th>
<th>8-hour averaging</th>
<th>24-hour averaging</th>
</tr>
</thead>
<tbody>
<tr>
<td>20 m down wind</td>
<td>1.55</td>
<td>0.19</td>
<td>0.13</td>
</tr>
<tr>
<td>30 m down wind</td>
<td>1.22</td>
<td>0.16</td>
<td>0.09</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Distance from Log Piles</th>
<th>1-hour averaging</th>
<th>8-hour averaging</th>
<th>24-hour averaging</th>
</tr>
</thead>
<tbody>
<tr>
<td>20 m down wind</td>
<td>&lt;0.01</td>
<td>0.020</td>
<td>0.030</td>
</tr>
<tr>
<td>30 m down wind</td>
<td>&lt;0.01</td>
<td>0.014</td>
<td>0.021</td>
</tr>
</tbody>
</table>

These results are available at this time for distributions based on all hours, not just limited to hours with active ventilation. This is why, for example, the 24-hour values are higher than the 8-hour (due to more zero values for 8-hours). Refer to Table E-4 for example 98th and 99th percentiles at the maximum boundary receptors for further perspective. Especially considering the proximity of the Western boundary to active fumigation, it is clear based on Table E-4 that at the 98th and 99th percentiles that the concentrations would be well below toxicological endpoints.
Table E-7: Summary of Maximum Modeled Concentrations Downwind of Fumigated Source Areas Considering Log Stacks and Ships at 20 m and 30 m Downwind Based on 700 ppm at Time of Ventilation

<table>
<thead>
<tr>
<th>Distance from Log Piles</th>
<th>1-hour averaging</th>
<th>8-hour averaging</th>
<th>24-hour averaging</th>
</tr>
</thead>
<tbody>
<tr>
<td>20 m down wind</td>
<td>1.09</td>
<td>0.13</td>
<td>0.09</td>
</tr>
<tr>
<td>30 m down wind</td>
<td>0.85</td>
<td>0.11</td>
<td>0.06</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Distance from Log Piles</th>
<th>1-hour averaging</th>
<th>8-hour averaging</th>
<th>24-hour averaging</th>
</tr>
</thead>
<tbody>
<tr>
<td>20 m down wind</td>
<td>&lt;0.01</td>
<td>&lt;=0.01</td>
<td>0.021</td>
</tr>
<tr>
<td>30 m down wind</td>
<td>&lt;0.01</td>
<td>&lt;=0.01</td>
<td>0.015</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Distance from Log Piles</th>
<th>1-hour averaging</th>
<th>8-hour averaging</th>
<th>24-hour averaging</th>
</tr>
</thead>
<tbody>
<tr>
<td>20 m down wind</td>
<td>&lt;0.01</td>
<td>&lt;=0.01</td>
<td>&lt;=0.01</td>
</tr>
<tr>
<td>30 m down wind</td>
<td>&lt;0.01</td>
<td>&lt;=0.01</td>
<td>&lt;=0.01</td>
</tr>
</tbody>
</table>

These results are available at this time for distributions based on all hours, not just limited to hours with active ventilation. This is why, for example, the 24-hour values are higher than the 8-hour (due to more zero values for 8-hours). Refer to Table E-4 for example 98\textsuperscript{th} and 99\textsuperscript{th} percentiles at the maximum boundary receptors for further perspective. Especially considering the proximity of the Western boundary to active fumigation, it is clear based on Table E-4 that at the 98\textsuperscript{th} and 99\textsuperscript{th} percentiles that the concentrations would be well below toxicological endpoints.
Dispersion Modeling of Ethanedinitrile Airborne Concentrations Associated with Timber Fumigation at the Port of Tauranga, New Zealand

Table E-6: Summary of Maximum Modeled Concentrations Downwind of Fumigated Source Areas Considering Log Stacks and Ships at 20 m and 30 m Downwind Based on 500 ppm at Time of Ventilation\(^\text{10}\)

<table>
<thead>
<tr>
<th>Distance from Log Files</th>
<th>1-hour averaging</th>
<th>8-hour averaging</th>
<th>24-hour averaging</th>
</tr>
</thead>
<tbody>
<tr>
<td>20 m down wind</td>
<td>0.78</td>
<td>0.10</td>
<td>0.07</td>
</tr>
<tr>
<td>30 m down wind</td>
<td>0.61</td>
<td>0.08</td>
<td>0.05</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Distance from Log Files</th>
<th>1-hour averaging</th>
<th>8-hour averaging</th>
<th>24-hour averaging</th>
</tr>
</thead>
<tbody>
<tr>
<td>20 m down wind</td>
<td>&lt;0.01</td>
<td>&lt;=0.01</td>
<td>0.015</td>
</tr>
<tr>
<td>30 m down wind</td>
<td>&lt;0.01</td>
<td>&lt;=0.01</td>
<td>&lt;=0.01</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Distance from Log Files</th>
<th>1-hour averaging</th>
<th>8-hour averaging</th>
<th>24-hour averaging</th>
</tr>
</thead>
<tbody>
<tr>
<td>20 m down wind</td>
<td>&lt;0.01</td>
<td>&lt;=0.01</td>
<td>&lt;=0.01</td>
</tr>
<tr>
<td>30 m down wind</td>
<td>&lt;0.01</td>
<td>&lt;=0.01</td>
<td>&lt;=0.01</td>
</tr>
</tbody>
</table>

\(^{10}\) These results are available at this time for distributions based on all hours, not just limited to hours with active ventilation. This is why, for example, the 24-hour values are higher than the 8-hour (due to more zero values for 8-hours). Refer to Table E-4 for example 98\(^{\text{th}}\) and 99\(^{\text{th}}\) percentiles at the maximum boundary receptors for further perspective. Especially considering the proximity of the Western boundary to active fumigation, it is clear based on Table E-4 that at the 98\(^{\text{th}}\) and 99\(^{\text{th}}\) percentiles that the concentrations would be well below toxicological endpoints.

Dispersion Modeling of Ethanedinitrile Airborne Concentrations Associated with Timber Fumigation at the Port of Tauranga, New Zealand
By way of perspective, it is important to consider the differences between ship fumigation and log stacks. The scales of fumigation and specific modeling specifications are quite different. Ships require a much greater mass of fumigant because of the greater volumes (~ 50,000 m$^3$) being treated as compared to log stacks (~ 1,500 to 12,500 m$^3$ depending on the number of log stack rows in the application). Ship ventilation also occurs at night when there typically is less favorable dispersion conditions than during the daytime when log stacks are fumigated. On this basis, it could be expected that the ship impacts would be substantially greater than log stacks. Using the most recent year of Port of Tauranga measured PID records (2019) for methyl bromide as an example, however, the measured data do not show this to be the case. The log stacks are creating higher measured 1-hour concentrations. There are several reasons why this is the case:

1. **Typically, one-fifth of the Total Fumigated Volume is Released Per Vent**: Unlike log stacks that are vented at one time, ship fumigation is treated as being vented one hour per hold. Even though the total volume and mass of the ship fumigation is much larger than log stacks, during any given hour only a small fraction is released.

2. **Longer Duration to Vent Ships**: The current assumption is that log stacks ventilate during the first hour, but ships require two hours to ventilate because of the larger volume and less exposed fumigation zone relative to the wind. This means that each vent only releases half of the fumigant in the headspace during each hour, effectively halving the resulting downwind concentration relative to a log stack of equal source strength. The longer duration of venting ships is attributed to the fact that log stacks are subject to ventilation on five surfaces, whereas the ship ventilation is only exposed at the top surface.

3. **Initial Dispersion**: Especially with the onshore flow, the initial volume into which the emissions are initially diluted is much larger for a ship as compared to the log stacks aligned parallel with the wind, with a smaller downwind cavity zone.

4. **Nighttime Dispersion**: Nocturnal applications generally would be expected to produce higher downwind airborne concentrations, all else being equal, because of two factors:
(1) lower wind speeds at night, and (2) more limited atmospheric dilution potential. The first term, wind speed, would be expected to increase modeled concentrations relative to the stronger daytime periods. The nocturnal atmospheric mixing issue, however, is reduced at the port because of the high heat capacity of the port asphalt surface. It would be expected that atmospheric dilution conditions would be approximately neutral at night over the asphalt surface (especially with lots of respiring timber stacked up on the surface). This would produce similar dispersion conditions as daytime conditions with relatively strong winds (common at the port) or during cloudy conditions. In total, the nighttime dispersion term would be expected to increase concentrations on balance, but less so in terms of buffer zone assessment in the near field because of the dominance of the large initial dispersion term caused by the shipping volume.

5. **Greater Number of Applications by Log Stacks as Compared to Ships:** In 2019 at the Port of Tauranga about 1700 log stacks were treated (913715 JAS). While about one third of that JAS volume was treated in ship holds numerically there simply are many more hours for the worst-case meteorology to align with the emissions for the log stacks compared with ship holds being treated to produce worst-case conditions. Table E-9 provides data on fumigation on log stacks as compared to ship fumigation.
Table E-9: Fumigation Data for 2019 Regarding Low Row Treatments in Comparison to Ship Fumigation.

<table>
<thead>
<tr>
<th>Area / Destination</th>
<th>No of Log Rows</th>
<th>Jas Volume</th>
</tr>
</thead>
<tbody>
<tr>
<td>Marsden Point</td>
<td>2584</td>
<td>1476818</td>
</tr>
<tr>
<td>China</td>
<td>2059</td>
<td>1211710</td>
</tr>
<tr>
<td>India</td>
<td>525</td>
<td>265108</td>
</tr>
<tr>
<td>Mount Logs</td>
<td>1706</td>
<td>913715</td>
</tr>
<tr>
<td>China</td>
<td>1501</td>
<td>812540</td>
</tr>
<tr>
<td>India</td>
<td>158</td>
<td>69708</td>
</tr>
<tr>
<td>Malaysia</td>
<td>1</td>
<td>104</td>
</tr>
<tr>
<td>Philippines</td>
<td>6</td>
<td>1314</td>
</tr>
<tr>
<td>Taiwan</td>
<td>40</td>
<td>30048</td>
</tr>
<tr>
<td>Napier</td>
<td>997</td>
<td>672604</td>
</tr>
<tr>
<td>China</td>
<td>887</td>
<td>583835</td>
</tr>
<tr>
<td>India</td>
<td>110</td>
<td>88769</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>5287</strong></td>
<td><strong>3063136</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Area / Destination</th>
<th>Hold Volume*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Marsden Point</td>
<td>1214937</td>
</tr>
<tr>
<td>China</td>
<td>82135</td>
</tr>
<tr>
<td>India</td>
<td>1132802</td>
</tr>
<tr>
<td>Mount Logs</td>
<td>358489</td>
</tr>
<tr>
<td>China</td>
<td>21670</td>
</tr>
<tr>
<td>India</td>
<td>336819</td>
</tr>
<tr>
<td>Napier</td>
<td>486108</td>
</tr>
<tr>
<td>China</td>
<td>45511</td>
</tr>
<tr>
<td>India</td>
<td>440597</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>2059534</strong></td>
</tr>
</tbody>
</table>
2.0 Introduction

The objective of this report is to show the expected airborne concentrations of EDN throughout the port area, with emphasis on concentrations along the port boundary. Averaging times are shown for 1-hour and 24-hour averages, and with worker exposure shown in Appendix F. The CALPUFF 7 dispersion model (Version 7.2.1) was run based on CALMET processing produced by Atmospheric Global Sciences, which has been used in other assessments of the Port of Tauranga and is considered as a standard meteorological data set for this region. CALPUFF 7 was run based on assuming 1,000 ppm concentration under a tarp just before ventilation. Also, analyses were performed for 500 ppm and 750 ppm concentrations under the tarp as alternative scenarios. The results in this assessment can be scaled up or down to address alternative pre-venting concentrations under the tarp.

The simulation of timber fumigation at the port was based on actual daily records, which showed when and where venting occurred, the amount of product used for the log stacks and ships, volume fumigated, mass applied (kg) and the location and time of venting. The port data are presented in Appendix D (electronic form for the Excel file that shows actual fumigation records on a day-by-day basis). Monte Carlo sampling methods were developed to conservatively represent the frequency of applications at the locations and time of day that the applications occur on a seasonal basis. The Monte Carlo sampling of applications was performed in a manner that represents actual port operations with some conservative bias to err on the side of overstating impacts: (1) log stack emissions for each of the four size groups was based on the largest source within each category, and (2) although the emissions were matched to the actual size of the log stack rows (50 m long x 5 m wide x 6 m high), the row length was compressed to 25 m x 5 m x 6 m, which concentrations the emissions and acts to conservatively represent the sources.

Modeling results are presented for a range of assumed in-tarp EDN concentrations at the time of venting (500, 700, and 1000 ppm) for the ship only scenarios, log stacks only scenarios, and
combined ship and log stack scenarios. Consistent with the expert panel for methyl bromide statement in Appendix A, the log stacks and ships were modeled as volume sources, with multiple sources used as necessary to approximate the volume by square sources and to minimize model bias due to source representation geometry. The results for log stacks and ships are presented separately and combined to provide a sufficient perspective on these emissions.

3.0 Basis for Fumigation

Appendix D provides the basis for the emissions treatment, i.e. day-by-day records for the most recently completed calendar year, 2019. It was assumed that all available EDN concentrations under the tarp were released in the first hour of ventilation (for log stacks) and the first two hours (in each ship hold). Figure E-1 shows the location of modeled for log stacks and ship volume sources were centered in each location with the sizes for the log stacks determined based on the number of rows fumigated. It was assumed that each log stack row was 5 m wide with 1 m spacing between rows. The length of each log stack was conservatively simulated as 25 m long\textsuperscript{11}, and 6 m high and 5 m wide. The length of time to vent was variable, especially for the larger log stack applications. The ships were all assumed to be at berths 9, 10 and 11 with dimensions 8 m above sea level and 30 m long. The probability of fumigation at each berth were modeled as follows: Berth 9 = 0.2, Berth 10 = 0.2, and Berth 11 = 0.6. Ship venting was modeled assuming one hatch was opened each hour with uniform emissions of all headspace emissions over two hours per hatch.

The Tauranga, New Zealand port data for Methyl Bromide applications were used as the basis for calculating all of the probabilities for the Ethanedinitrile (C\textsubscript{2}N\textsubscript{2} or EDN) modeling. The data included all of the dates, times, amount of Methyl Bromide applied, capacity (volume) of the log pile sources that were vented, and the number of log rows or ship holds vented. The assumptions for EDN modeling were to assume all venting would occur during a randomly selected 1-hour

\textsuperscript{11} The actual length of log rows is approximately 50 m; the emission rate was based on a volume consistent with 50 m, but the source size compressed which acted to increase the conservatism of the assessment. If 50 m log stack rows are used in the future, the modeled concentrations will decrease.
period based upon the concentration under the tarp of 1000, 700, and 500 ppm of EDN. The number of applications and number of log rows applied was distributed differently by season, so each season was analyzed separately for a variety of probability calculations including the following probabilities of occurrences per day for every season:

1) The occurrence of Log Row Venting Event
2) The occurrence of Log Row Venting Event in a Particular Zone
3) The occurrence of Log Row Venting Event in the Same Zone on the Same Day
4) The occurrence of Multiple Log Row Venting Events per Day in Different Zones
5) The occurrence of Log Row Venting Event by Hour of Day
6) The occurrence of Ship Hold Venting Event
7) The occurrence of Ship Hold Venting Event by Berth Location
8) The occurrence of Ship Hold Venting Event by Hour of Day
9) The occurrence of Ship Hold Venting Event.
Dispersion Modeling of Ethanedinitrile Airborne Concentrations Associated with Timber Fumigation at the Port of Tauranga, New Zealand

<table>
<thead>
<tr>
<th>Ship venting</th>
<th>Probability range in values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Probability of Daily Occurrence of Event</td>
<td>0.011-0.22 (based on season)</td>
</tr>
<tr>
<td>Ship Berth #</td>
<td>9-11 (0.2 for Berths 9 and 10 and 0.6 for Berth 11)</td>
</tr>
<tr>
<td>Start Time for Event</td>
<td>10 PM - 2 AM (Summer = set to 6 - 7 AM)</td>
</tr>
<tr>
<td>Number of Ship Holds Venting</td>
<td>1.0 for 5 Holds (0.5 for 2 or 5 Holds in Summer)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Log row venting</th>
<th>Probability range in values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Probability of Daily Occurrence of Event</td>
<td>0.467-0.685 (based on season)</td>
</tr>
<tr>
<td>Start Time for Event</td>
<td>7 AM – 8 PM (various for each hour based on season)</td>
</tr>
<tr>
<td>Multiple Applications on Same Day</td>
<td>0.256-0.385 (based on season)</td>
</tr>
<tr>
<td>Number of Zones Applied</td>
<td>1-5 Zones (varies based on season)</td>
</tr>
<tr>
<td>Zone Applied</td>
<td>Zone #s 1, 2, 3, 6, or 7 (varies based on season)</td>
</tr>
<tr>
<td>Additional Applications in the Same Zone</td>
<td>1-3 Applications (varies based on season)</td>
</tr>
</tbody>
</table>

To determine the various number of rows used for each zone, the data were sorted by each season and the summer was used as a basis for predicting the largest number of rows source sizes per zone across all seasons as shown below.

<table>
<thead>
<tr>
<th>Selection of Source Sizes Per Zone Across All Seasons</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zone #</td>
</tr>
<tr>
<td>Largest Source</td>
</tr>
<tr>
<td>2nd Largest Source</td>
</tr>
<tr>
<td>2nd Smallest Source</td>
</tr>
<tr>
<td>Smallest Source</td>
</tr>
</tbody>
</table>

Dispersion Modeling of Ethanedinitrile Airborne Concentrations Associated with Timber Fumigation at the Port of Tauranga, New Zealand
Each row source was set to 25 meters by each side except for the sources less than 25 x 25 square meters that were set to a lower value of 5 meters by each side and these were used in the CALPUFF modeling setup.

<table>
<thead>
<tr>
<th>Zone #</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>6</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Largest Source</td>
<td>4.5</td>
<td>3.3</td>
<td>5.2</td>
<td>2.6</td>
<td>1.9</td>
</tr>
<tr>
<td>2nd Largest Source</td>
<td>3.3</td>
<td>1.6</td>
<td>2.4</td>
<td>1.9</td>
<td>0.9</td>
</tr>
<tr>
<td>2nd Smallest Source</td>
<td>2.4</td>
<td>0.9</td>
<td>1.4</td>
<td>0.9</td>
<td>2.2</td>
</tr>
<tr>
<td>Smallest Source</td>
<td>1.2</td>
<td>1.0</td>
<td>2.2</td>
<td>1.0</td>
<td>1.0</td>
</tr>
</tbody>
</table>

Each Sub-Volume Source is 25 x 25 meters
Largest Source is 5 x 25 m or 125 m long (N-S) and 25 m wide (E-W)
Yellow Sub-Sources are 5 x 5 squares rather than 25 x 25 square size.

The emission rates were determined by using the concentrations under the tarp of each application and emitting the headspace volume of 42 percent of the air space in one hour for the log stack rows and within two hours for the ship holds (also with 42 percent air space) to estimate the grams/second emission rate for each of the volume sources.

| Emission Rate Calculations Basis for EDN Temperature of 22 Celsius |
|-----------------------------|-------------------|------------------|
| Concentration (ppm) | Molecular Weight EDN | Concentration (g/m³) |
| 500                      | 52                | 1.134            |
| 700                      | 52                | 1.587            |
| 1000                     | 52                | 2.267            |
Source Emission Rates (g/s)

<table>
<thead>
<tr>
<th>Concentration (ppm)</th>
<th>Large Row Source</th>
<th>Small Row Source</th>
<th>Ship Hold</th>
</tr>
</thead>
<tbody>
<tr>
<td>500</td>
<td>0.10</td>
<td>0.02</td>
<td>0.26</td>
</tr>
<tr>
<td>700</td>
<td>0.14</td>
<td>0.03</td>
<td>0.36</td>
</tr>
<tr>
<td>1000</td>
<td>0.20</td>
<td>0.04</td>
<td>0.51</td>
</tr>
</tbody>
</table>

FORTRAN programs used to develop these probabilities and the Julian days in each season including an additional day during the 2016 leap year as three years of meteorological data were used in the modeling from 2014-2016.

<table>
<thead>
<tr>
<th>Season</th>
<th>Start Julian Date</th>
<th>End Julian Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Summer 1</td>
<td>1</td>
<td>59</td>
</tr>
<tr>
<td>Fall</td>
<td>60</td>
<td>151</td>
</tr>
<tr>
<td>Winter</td>
<td>152</td>
<td>243</td>
</tr>
<tr>
<td>Spring</td>
<td>244</td>
<td>334</td>
</tr>
<tr>
<td>Summer 2</td>
<td>335</td>
<td>365</td>
</tr>
</tbody>
</table>

The season with the largest amount of methyl bromide used was the fall as shown below based on the amount of methyl bromide use at the Tauranga Port during 2019. There were a variety of hours during which a venting event occurred and generally they were more pronounced during the late morning hours and early afternoon of each month as shown in Figure E-2. Most of the ship venting events occurred at night between 10 PM and 1 AM. During the summer the ship venting event occurred at 6 AM.
4.0 Hourly Emissions Scenarios

A FORTRAN program was created that produced an hourly emission file for CALPUFF that realistically simulated port operations. The FORTRAN program and associated output files are presented in Appendix C.

5.0 CALPUFF Modeling

The CALPUFF (version 7.2.1) model was run using pre-processed monthly CALMET data files for the Port of Tauranga, New Zealand area for the period Jan 2014 through December 2016. The model runs were conducted for two sets of source data. One set consisted of five groups of log piles per fumigation area location. The second set was comprised of three berths where ships are fumigated at the port. Summaries of the modeled sources for both sets are provided in Tables 1 and 2. The relative location of these modeled sources along with the boundary of the port area is presented in Figure 1. Hourly emissions files for both sets of sources were used in each of these CALPUFF runs. Details on the processing of these hourly emission files are provided in Appendix C.

Both CALPUFF runs consisted of a total of 9,362 model grid receptors. Within that set of receptors were 346 fence line grid points that were established with a 20-meter spacing all along this border and are identified in Figure 2. In addition to the boundary receptors, multiple sets of nested grid receptors were established within and around the port area. First, a rectangular grid with receptors, with a grid spacing of 25-meters, extended north-south across most of the port area and covering the location of the five sets of log piles within the port. The second nested grid is a 50-meter spaced grid that extends outward from the port area out to 1 kilometer from the fence line. The third nested grid consisted of a 100-meter spaced grid that extends out to 3 kilometers from the fence line. All these receptors were modeled with a flagpole height of 1.52 meters (breathing height) above the ground. The complete set of these nested and fence line grids relative to the modeled sources is displayed in Figure 2.
A plot of the terrain heights of the port area modeled region is provided in Figure 3. These terrain heights were applied to all modeled sources (as shown in Tables 1 and 2) and all 9,362 modeled receptors.

Each of the CALPUFF model concentration output files was processed through CALPOST to produce 1-hour, 24-hour, and period-average concentrations for EDN in percentile format. The most significant concentrations in terms of health endpoint concentrations determined by the New Zealand regulators are 2 ppm for 1-hour averaging and 0.034 ppm for 24-hour averaging.
Table 1: Summary of Modeled Log Pile Sources

<table>
<thead>
<tr>
<th>Type</th>
<th>Source Description</th>
<th>Base Elevation</th>
<th>Height</th>
<th>Sigma Y</th>
<th>Sigma Z</th>
<th>Length X</th>
<th>Ventilation Emission Rate</th>
<th>UTM X</th>
<th>UTM Y</th>
</tr>
</thead>
<tbody>
<tr>
<td>VOLUME</td>
<td>Source Group 1 A1</td>
<td>11.50</td>
<td>3.30</td>
<td>5.81</td>
<td>2.79</td>
<td>25.00</td>
<td>0.20</td>
<td>427970</td>
<td>5811895</td>
</tr>
<tr>
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<td>Source Group 1 A2</td>
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<td>5.81</td>
<td>2.79</td>
<td>25.00</td>
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<td>5811923</td>
</tr>
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<td>2.79</td>
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<td>0.20</td>
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</tr>
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<td>Source Group 1 D1</td>
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<td>2.79</td>
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</tr>
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</tbody>
</table>
Table 2: Summary of Modeled Ship Sources

<table>
<thead>
<tr>
<th>Type</th>
<th>ID</th>
<th>Source Description</th>
<th>Base Elev</th>
<th>Height</th>
<th>Sigma X</th>
<th>Sigma Y</th>
<th>Length X</th>
<th>Ventilation Emission Rate</th>
<th>UTM-X</th>
<th>UTM-Y</th>
</tr>
</thead>
<tbody>
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<td>Ship Berth 9A</td>
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Figure 1: Location of Modeled Sources (Dark Blue) and Facility Boundary (Yellow)
Figure 2: The layout of Modeled Receptor Grids (green) and Sources (dark blue)
Figure 3: Terrain Elevations (meters) of the Port Area Modeled Region.
5.0 Model Results

The tables show the distribution of exposures for the boundary receptors based on 500, 700, and 1000 ppm concentrations under the tarp at the time of ventilation. The figures are most effectively presented for the 1000 ppm scenario. To interpret for 500 ppm scenario, divide the labels by a factor of 2. For the 700 ppm scenario, divide the labels by a factor of 1.4. Note that all hourly emission files, CALMET, and CALPUFF input and output files are available electronically, upon request.

- Tables 3 through 11 present the distributions of 1-hour concentrations for the boundary receptor grid for 500, 700, and 1000 ppm under the tarp concentration at the time of ventilation with distributions based on all hours.

- Tables 12 through 20 present the distributions of 1-hour concentrations for the boundary receptor grid for 500, 700, and 1000 ppm under the tarp concentration at the time of ventilation with distributions based on hours with active ventilation only.

- Tables 21 through 29 present the distributions of 24-hour concentrations for boundary receptor grid for 500, 700, and 1000 ppm under the tarp concentration at the time of ventilation with distributions based on all hours.

- Tables 30 through 38 present the distributions of 24-hour concentrations for the boundary receptor grid for 500, 700, and 1000 ppm under the tarp concentration at the time of ventilation with distributions based on hours with active ventilation only.

- Figures 4-12 present the 98-100th percentile 1-Hour Concentrations Based on all Hours for the Extended Receptor Grid.

- Figures 13-21 present the 98-100th percentile 1-Hour Concentrations Based on Hours with Active Ventilation based on the receptor grid within the port.
Table 3: 1-Hour Average Percentile Concentrations (90\textsuperscript{th} – 100\textsuperscript{th} Percentile) for EDN for Log Stacks Only Based on 500 ppm Concentrations under the Tarp at the Time of Venting for Top 25 Boundary Receptors Based on Distributions Including All Hours

Concentrations in Tables Are Presented as \textit{Ppb} to Allow for More Significant Figures

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Table 4: 1-Hour Average Percentile Concentrations (90th – 100th Percentile) for EDN for Log Stacks Only Based on 700 ppm Concentrations Under the Tarp at the Time of Venting for Top 25 Boundary Receptors Based on Distributions Including All Hours

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Table 5: 1-Hour Average Percentile Concentrations (90th – 100th Percentile) for EDN for Log Stacks Only Based on 1,000 ppm Concentrations Under the Tarp at the Time of Venting for Top 25 Boundary Receptors Based on Distributions Including All Hours
Concentrations in Tables Are Presented as **Ppb** to Allow for More Significant Figures

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Table 6: 1-Hour Average Percentile Concentrations (90th – 100th Percentile) for EDN for Ships Only Based on 500 ppm Concentrations Under the Tarp at the Time of Venting for Top 25 Boundary Receptors Based on Distributions Including All Hours

Since there are a limited number of values for the intermittent ship fumigation events to calculate percentiles, refer to the log row and ship combination Table 9 for further information.
Table 7: 1-Hour Average Percentile Concentrations (90th – 100th Percentile) for EDN for Ships Only Based on 700 ppm Concentrations Under the Tarp at the Time of Venting for Top 25 Boundary Receptors Based on Distributions Including All Hours

Since there are a limited number of values for the intermittent ship fumigation events to calculate percentiles, refer to the log row and ship combination Table 10 for further information.
Table 8: 1-Hour Average Percentile Concentrations (90th – 100th Percentile) for EDN for Ships Only Based on 1,000 ppm Concentrations Under the Tarp at the Time of Venting for Top 25 Boundary Receptors Based on Distributions Including All Hours

Since there are a limited number of values for the intermittent ship fumigation events to calculate percentiles, refer to the log row and ship combination Table 11 for further information.
Table 9: 1-Hour Average Percentile Concentrations (90th – 100th Percentile) for EDN for Log Stacks and Ships Based on 500 ppm Concentrations Under the Tarp at the Time of Venting for Top 25 Boundary Receptors Based on Distributions Including All Hours

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Table 10: 1-Hour Average Percentile Concentrations (90th – 100th Percentile) for EDN for Log Stacks and Ships Based on 700 ppm Concentrations Under the Tarp at the Time of Venting for Top 25 Boundary Receptors Based on Distributions Including All Hours

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Table 11: 1-Hour Average Percentile Concentrations (90th – 100th Percentile) for EDN for Log Stacks and Ships Based on 1,000 ppm Concentrations Under the Tarp at the Time of Venting for Top 25 Boundary Receptors Based on Distributions Including All Hours

Concentrations in Tables Are Presented as Ppb to Allow for More Significant Figures

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Table 13: 1-Hour Average Percentile Concentrations (90th – 100th Percentile) for EDN for Log Stacks Only Based on 700 ppm Concentrations Under the Tarp at the Time of Venting for Top 25 Boundary Receptors Only Based on Hours When Active Ventilation Occurs

Concentrations in Tables Are Presented as Ppb to Allow for More Significant Figures

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700 PPM APPLICATION (NON-ZERO RESULTS ONLY)

TOP 25 1-HOUR AVERAGED EDN LOG ROW FENCING CONCENTRATIONS (PPB)
Table 14: 1-Hour Average Percentile Concentrations (90th – 100th Percentile) for EDN for Log Stacks Only Based on 1,000 ppm Concentrations Under the Tarp at the Time of Venting for Top 25 Boundary Receptors Only Based on Hours When Active Ventilation Occurs

Concentrations in Tables Are Presented as Ppb to Allow for More Significant Figures

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Table 15: 1-Hour Average Percentile Concentrations (90th – 100th Percentile) for EDN for Ships Only Based on 500 ppm Concentrations Under the Tarp at the Time of Venting for Top 25 Boundary Receptors Only Based on Hours When Active Ventilation Occurs

Since there are a limited number of values for the intermittent ship fumigation events to calculate percentiles, refer to the log row and ship combination Table 18 for further information.
Table 16: 1-Hour Average Percentile Concentrations (90th – 100th Percentile) for EDN for Ships Only Based on 700 ppm Concentrations Under the Tarp at the Time of Venting for Top 25 Boundary Receptors Only Based on Hours When Active Ventilation Occurs

Since there are a limited number of values for the intermittent ship fumigation events to calculate percentiles, refer to the log row and ship combination Table 19 for further information.
Table 17: 1-Hour Average Percentile Concentrations (90th – 100th Percentile) for EDN for Ships Only Based on 1,000 ppm Concentrations Under the Tarp at the Time of Venting for Top 25 Boundary Receptors Based on Hours When Active Ventilation Occurs

Since there are a limited number of values for the intermittent ship fumigation events to calculate percentiles, refer to the log row and ship combination Table 20 for further information.
Table 18: 1-Hour Average Percentile Concentrations (90th – 100th Percentile) for EDN for Log Stacks and Ships Based on 500 ppm Concentrations Under the Tarp at the Time of Venting for Top 25 Boundary Receptors Only Based on Hours When Active Ventilation Occurs

Concentrations in Tables Are Presented as Ppb to Allow for More Significant Figures

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Table 19: 1-Hour Average Percentile Concentrations (90th – 100th Percentile) for EDN for Log Stacks and Ships Based on 700 ppm Concentrations Under the Tarp at the Time of Venting for Top 25 Boundary Receptors Only Based on Hours When Active Ventilation

Concentrations in Tables Are Presented as Ppb to Allow for More Significant Figures

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Table 20: 1-Hour Average Percentile Concentrations (90th – 100th Percentile) for EDN for Log Stacks and Ships Based on 1,000 ppm Concentrations Under the Tarp at the Time of Venting for Top 25 Boundary Receptors Only Based on Hours When Active Ventilation Occurs

Concentrations in Tables Are Presented as Ppb to Allow for More Significant Figures

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Table 21: 24-Hour Average Percentile Concentrations (90th – 100th Percentile) for EDN for Log Stacks Only Based on 500 ppm Concentrations Under the Tarp at the Time of Venting for Top 25 Boundary Receptors Based on Distributions Including All Hours

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Table 22: 24-Hour Average Percentile Concentrations (90th – 100th Percentile) for EDN for Log Stacks Only Based on 700 ppm Concentrations Under the Tarp at the Time of Venting for Top 25 Boundary Receptors Based on Distributions Including All Hours

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### Table 23: 24-Hour Average Percentile Concentrations (90th – 100th Percentile) for EDN for Log Stacks Only Based on 1,000 ppm Concentrations Under the Tarp at the Time of Venting for Top 25 Boundary Receptors Based on Distributions Including All Hours

Concentrations in Tables Are Presented as Ppb to Allow for More Significant Figures

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Top 25 24-Hour Averaged EDN Log Row Fence Line Concentrations (PPB)
Table 24: 24-Hour Average Percentile Concentrations (90th – 100th Percentile) for EDN for Ships Only Based on 500 ppm Concentrations Under the Tarp at the Time of Venting for Top 25 Boundary Receptors Based on Distributions Including All Hours

Since there are a limited number of values for the intermittent ship fumigation events to calculate percentiles, refer to the log row and ship combination Table 27 for further information.
Table 25: 24-Hour Average Percentile Concentrations (90th – 100th Percentile) for EDN for Ships Only Based on 700 ppm Concentrations Under the Tarp at the Time of Venting for Top 25 Boundary Receptors Based on Distributions Including All Hours

Since there are a limited number of values for the intermittent ship fumigation events to calculate percentiles, refer to the log row and ship combination Table 27 for further information.
Table 26: 24-Hour Average Percentile Concentrations (90th – 100th Percentile) for EDN for Ships Only Based on 1,000 ppm Concentrations Under the Tarp at the Time of Venting for Top 25 Boundary Receptors Based on Distributions Including All Hours

Since there are a limited number of values for the intermittent ship fumigation events to calculate percentiles, refer to the log row and ship combination Table 29 for further information.
Table 27: 24-Hour Average Percentile Concentrations (90th – 100th Percentile) for EDN for Log Stacks and Ships Based on 500 ppm Concentrations Under the Tarp at the Time of Venting for Top 25 Boundary Receptors Based on Distributions Including All Hours

Concentrations in Tables Are Presented as **Ppb** to Allow for More Significant Figures

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Table 28: 24-Hour Average Percentile Concentrations (90th – 100th Percentile) for EDN for Log Stacks and Ships Based on 700 ppm Concentrations Under the Tarp at the Time of Venting for Top 25 Boundary Receptors Based on Distributions Including All Hours

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Table 29: 24-Hour Average Percentile Concentrations (90th – 100th Percentile) for EDN for Log Stacks and Ships Based on 1,000 ppm Concentrations Under the Tarp at the Time of Venting for Top 25 Boundary Receptors Based on Distributions Including All Hours

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Dispersion Modeling of Ethanedinitrile Airborne Concentrations Associated with Timber Fumigation at the Port of Tauranga, New Zealand
Table 30: 24-Hour Average Percentile Concentrations (90th – 100th Percentile) for EDN for Log Stacks Only Based on 500 ppm Concentrations Under the Tarp at the Time of Venting for Top 25 Boundary Receptors Based on Distributions Only Based on Hours When Active Ventilation Occurs

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Table 31: 24-Hour Average Percentile Concentrations (90th – 100th Percentile) for EDN for Log Stacks Only Based on 700 ppm Concentrations Under the Tarp at the Time of Venting for Top 25 Boundary Receptors Only Based on Hours When Active Ventilation Occurs

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Table 32: 24-Hour Average Percentile Concentrations (90th – 100th Percentile) for EDN for Log Stacks Only Based on 1,000 ppm Concentrations Under the Tarp at the Time of Venting for Top 25 Boundary Receptors Only Based on Hours When Active Ventilation Occurs

Concentrations in Tables Are Presented as Ppb to Allow for More Significant Figures

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Table 33: 24-Hour Average Percentile Concentrations (90th – 100th Percentile) for EDN for Ships Only Based on 500 ppm Concentrations Under the Tarp at the Time of Venting for Top 25 Boundary Receivers Only Based on Hours When Active Ventilation Occurs

Since there are a limited number of values for the intermittent ship fumigation events to calculate percentiles, refer to the log row and ship combination Table 36 for further information.
Table 34: 24-Hour Average Percentile Concentrations (90th – 100th Percentile) for EDN for Ships Only Based on 700 ppm Concentrations Under the Tarp at the Time of Venting for Top 25 Boundary Receptors Only Based on Hours When Active Ventilation Occurs

Since there are a limited number of values for the intermittent ship fumigation events to calculate percentiles, refer to the log row and ship combination Table 36 for further information.
Table 35: 24-Hour Average Percentile Concentrations (90th – 100th Percentile) for EDN for Ships Only Based on 1,000 ppm Concentrations Under the Tarp at the Time of Venting for Top 25 Boundary Receptors Based on Hours When Active Ventilation Occurs

Since there are a limited number of values for the intermittent ship fumigation events to calculate percentiles, refer to the log row and ship combination Table 38 for further information.
Table 36: 24-Hour Average Percentile Concentrations (90th – 100th Percentile) for EDN for Log Stacks and Ships Based on 500 ppm Concentrations Under the Tarp at the Time of Venting for Top 25 Boundary Receptors Only Based on Hours When Active Ventilation Occurs

Concentrations in Tables Are Presented as Ppb to Allow for More Significant Figures
### Table 37: 24-Hour Average Percentile Concentrations (90th – 100th Percentile) for EDN for Log Stacks and Ships Based on 700 ppm Concentrations Under the Tarp at the Time of Venting for Top 25 Boundary Receptors Only Based on Hours When Active Ventilation Occurs

Concentrations in Tables Are Presented as Ppb to Allow for More Significant Figures

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Table 38: 24-Hour Average Percentile Concentrations (90th – 100th Percentile) for EDN for Log Stacks and Ships Based on 1,000 ppm Concentrations Under the Tarp at the Time of Venting for Top 25 Boundary Receptors Only Based on Hours When Active Ventilation Occurs

Concentrations in Tables Are Presented as Ppb to Allow for More Significant Figures

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<tr>
<td>21</td>
<td>16.39133</td>
</tr>
<tr>
<td>22</td>
<td>16.18717</td>
</tr>
<tr>
<td>23</td>
<td>15.82824</td>
</tr>
<tr>
<td>24</td>
<td>15.70097</td>
</tr>
<tr>
<td>25</td>
<td>12.95556</td>
</tr>
</tbody>
</table>
Figure 4: 1-Hour Average Isopleth Analysis of 98th Percentile for Extended Receptor Grid for Log Stacks Only Based on 1,000 ppm Concentrations Under the Tarp at the Time of Venting Based on Distributions Including All Hours

ALL RESULTS ARE ZERO
Figure 5: 1-Hour Average Isopleth Analysis of 99th Percentile for Extended Receptor Grid for Log Stacks Only Based on 1,000 ppm Concentrations Under the Tarp at the Time of Venting Based on Distributions Including All Hours
Figure 6: 1-Hour Average Isopleth Analysis of 100th Percentile for Extended Receptor Grid for Log Stacks Only Based on 1,000 ppm Concentrations Under the Tarp at the Time of Venting Based on Distributions Including All Hours
Figure 7: 1-Hour Average Isopleth Analysis of 98th Percentile for Extended Receptor Grid for Ships Only Based on 1,000 ppm Concentrations Under the Tarp at the Time of Venting Based on Distributions Including All Hours

ALL RESULTS ARE ZERO
Figure 8: 1-Hour Average Isopleth Analysis of 99th Percentile for Extended Receptor Grid for Ships Only Based on 1,000 ppm Concentrations Under the Tarp at the Time of Venting Based on Distributions Including All Hours

ALL RESULTS ARE ZERO
Figure 9: 1-Hour Average Isopleth Analysis of 100th Percentile for Extended Receptor Grid for Ships Only Based on 1,000 ppm Concentrations Under the Tarp at the Time of Venting Based on Distributions Including All Hours
Figure 10: 1-Hour Average Isoleth Analysis of 98th\textsuperscript{th} Percentile for Extended Receptor Grid for Log Stacks and Ships Based on 1,000 ppm Concentrations Under the Tarp at the Time of Venting Based on Distributions Including All Hours

ALL RESULTS ARE ZERO
Figure 11: 1-Hour Average Isopleth Analysis of 99th Percentile for Extended Receptor Grid for Log Stacks and Ships Based on 1,000 ppm Concentrations Under the Tarp at the Time of Venting Based on Distributions Including All Hours
Figure 12: 1-Hour Average Isopleth Analysis of 100th Percentile for Extended Receptor Grid for Log Stacks and Ships Based on 1,000 ppm Concentrations Under the Tarp at the Time of Venting Based on Distributions Including All Hours
Figure 13: 24-Hour Average Isopleth Analysis of 98th Percentile for Extended Receptor Grid for Log Stacks Only Based on 1,000 ppm Concentrations Under the Tarp at the Time of Venting Based on Distributions Including All Hours
Figure 14: 24-Hour Average Isopleth Analysis of 99th Percentile for Extended Receptor Grid for Log Stacks Only Based on 1,000 ppm Concentrations Under the Tarp at the Time of Venting Based on Distributions Including All Hours.
Figure 15: 24-Hour Average Isopleth Analysis of 100th Percentile for Extended Receptor Grid for Log Stacks Only Based on 1,000 ppm Concentrations Under the Tarp at the Time of Venting Based on Distributions Including All Hours
Figure 16: 24-Hour Average Isopleth Analysis of 98th Percentile for Extended Receptor Grid for Ships Only Based on 1,000 ppm Concentrations Under the Tarp at the Time of Venting Based on Distributions Including All Hours

ALL RESULTS ARE ZERO
Figure 17: 24-Hour Average Isopleth Analysis of 99th Percentile for Extended Receptor Grid for Ships Only Based on 1,000 ppm Concentrations Under the Tarp at the Time of Venting Based on Distributions Including All Hours.
Figure 18: 24-Hour Average Isopleth Analysis of 100th Percentile for Extended Receptor Grid for Ships Only Based on 1,000 ppm Concentrations Under the Tarp at the Time of Venting Based on Distributions Including All Hours
Figure 19: 24-Hour Average Isopleth Analysis of 98th Percentile for Extended Receptor Grid for Log Stacks and Ships Based on 1,000 ppm Concentrations Under the Tarp at the Time of Venting Based on Distributions Including All Hours.
Figure 20: 24-Hour Average Isopleth Analysis of 99th Percentile for Extended Receptor Grid for Log Stacks and Ships Based on 1,000 ppm Concentrations Under the Tarp at the Time of Venting Based on Distributions Including All Hours
Figure 21: 24-Hour Average Isopleth Analysis of 100th Percentile for Extended Receptor Grid for Log Stacks and Ships Based on 1,000 ppm Concentrations Under the Tarp at the Time of Venting Based on Distributions Including All Hours
7.0 Conclusions

This assessment provides insight into the expected emissions of EDN following expected fumigation procedures and application frequency.
References

January 30, 2020 signed memorandum from the Expert Panel for the New Zealand Environmental Protection Agency.12

12 This document is available upon request.
Appendix A: Joint Statement of Expert Panel on Methyl Bromide Fumigation Modeling of Airborne Exposures
BEFORE THE ENVIRONMENTAL PROTECTION AUTHORITY

IN THE MATTER of the Hazardous Substances and New Organisms Act 1996 (the Act)

AND

IN THE MATTER of the Decision-Making Committee with delegated responsibility for powers and functions related to the hearing and deciding of applications under the Act to reassess the approval for methyl bromide.

THE DECISION-MAKING COMMITTEE

Tipene Wilson (Chair)
Derek Belton
Ngaire Phillips

JOINT STATEMENT OF EXPERTS IN THE FIELD OF AIR DISPERSION MODELLING

30 January 2020

PARTICIPANTS: David Sullivan, Aleks Todoroski, Jennifer Barclay, Cathy Nieuwenhuisen

DATE AND TIME OF CONFERENCING: Thursday 30 January 2020 9:00am
INTRODUCTION
1. This signed joint witness statement is provided in response to the Decision-Making Committee’s Directions and Minutes WGT002 to WGT006.
2. This joint witness statement relates to the conferencing topic of Air Concentration Dispersion Modelling.
4. The conference was attended by:
   David Sullivan, Aleks Todoroski, Jennifer Barclay, Cathy Nieuwenhuijsen

CODE OF CONDUCT AND HEARING PROCEDURES
5. We confirm that we have read the Environment Court’s Code of Conduct 2014 and agree to comply with it. We confirm that the issues addressed in this Joint Statement are within our area of expertise.
6. We confirm that we are familiar with the Hearing Procedures issued by the EPA to the extent that they relate to this expert conferencing.

SCOPE OF STATEMENT
7. In our conference we discussed the issues relevant to the air dispersion modelling which arise within our field of expertise. Prior to attending the conference, we each read the relevant parts of previous air dispersion modelling, the evidence, and independent reports prepared by the other expert(s) and circulated.
8. The issues relate to:
   a. Modelling choice
   b. Monitoring - existing and future
   c. Representative modelling scenarios
   d. Specific model settings
   e. Data flow and information sharing
9. In this Joint Statement we report the outcome of our discussions in relation to each issue by reference to points of agreement and disagreement. Where we are not agreed in relation to any issue, we have set out the nature and basis of that disagreement.

LIST OF ISSUES
10. We considered the following issues, and have listed them below in an approximately order of priority.

ISSUE 1: Modelling choice
11. The experts all agree that the one-hour time step 3D CalMet data set (2014-2016) developed by ASG (2018) for the Bay of Plenty Regional Council (BOPRC) shall be used to assess the fumigation at Port of Tauranga. Consequently, the experts all agree that CALPUFF Version 7.2.1 L150618 shall be used as the dispersion model.
12. Mr Sullivan agrees with the selection of CALPUFF Version 7.2.1 rather than AERMOD because the selected version of CALPUFF contains the updated features that are in the current version AERMOD.

ISSUE 2 – Monitoring - Existing and Future

Existing Monitoring Data

13. To ensure all of the experts have the same data available to evaluate models the experts request that the DMC direct that the raw measured air quality data, associated metadata, QA/QC and any associated reports collected by the following organisations are made available to the expert witnesses as soon as possible (e.g. within two weeks) in a consolidated electronic format (e.g. excel spreadsheet).
   a. WorkSafe
   b. BOPRC
   c. Genera (Golder data and annual audit data comparing canister and PID)

For all these organisations, Summa canister and associated PID data from 2018 onwards is needed. In addition, Genera is requested to provide to all the experts the results of any investigations of canister and PID data.

14. The experts agree that the order of reliability of monitoring is as follows:
   a. Cannisters and sampling tubes
   b. PID with air pumped
   c. PID non pumped (e.g. cub PID)

Future Monitoring

15. The experts recommend that future monitoring should combine method 14 a. and 14 b. concurrently. This will allow continuous data collected as per method 14 b. to be validated with a more robust single result from method 14 a. Monitoring should be conducted in accordance with a sampling protocol developed or reviewed by a suitably qualified expert. All analysis should be undertaken by a laboratory accredited by the sampling protocol and using a detection limit at least ten times lower than the applicable criteria.

16. The sampling protocol should include at least the following:
   a. For each fumigation during sampling GPS coordinates of the four log pile corners, the log pile height, dose rates, initial and release time concentration.
   b. Reference to meteorological data to assist with downwind monitor location placement.
   c. Whether recapture was done or not.
   d. Sequencing and timing of fumigation events including tarp removal start and end time.
   e. The GPS coordinates of the monitor, the monitor height and the start and end time of the monitoring.
   f. Photographs of the monitors and the log pile.
17. The experts discussed the various model scenarios and setting and agreed on the following key parameters in the table below. They agreed that there were three distinct receptor zones. The near zone is to address the possible short-term STEL (15 minutes). The mid zone is to particularly consider other port workers excluding applicators. The far zone is where the public may be exposed.

<table>
<thead>
<tr>
<th>Near</th>
<th>Mid</th>
<th>Far</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sensitive people</strong></td>
<td>Applicator within the safety zone</td>
<td>Port workers</td>
</tr>
<tr>
<td><strong>Results</strong></td>
<td>Show distribution of percentile results for 1-hour results.</td>
<td>Show distribution of percentile results for 1-hour results.</td>
</tr>
</tbody>
</table>
| **Receptors** | Ring at >15 points per ring and 5m ring internal spacing downstream for single event modeling. | 25m grid from sources out to the port boundary. Boundary receptors at 23m. | 50m spacing to 1km
100m spacing 1km to 3km (9km x 8km domain) |
| **Source Type** | Logs and ships’ holds as volume sources. | Logs and ships’ holds as volume sources. | Logs and ships’ holds as volume sources. |
| **Source Parameters** | All square sources
Sigma = diagonal length
Effective height = 3m log stacks
= 8m above sea level for ship width >30m |
| **Source Scenarios** | Logs and Ships modelled separately plus event modeling and worst-case scenario. | Logs and Ships modelled separately and then together. | Logs and Ships modelled separately and then together. |
| **Log repair** | 50% sorted by logs | | |
| **Log Emissions** | As per measured data 2019 and a worst case and a real live sub hourly event. | As per measured data 2019 with Monte Carlo simulation to assess variability due to recapture variability. | As per measured data 2019 with Monte Carlo simulation to assess variability due to recapture variability. |
| **Recapture** | An event with no recapture and high application rate. at 150kg | 75% of mass. modelled as 75% of top stack and |
70% of mass. modelled as 70% of top stack and 90% of
<table>
<thead>
<tr>
<th><strong>Dispersion Modeling of Ethanedinitrile Airborne Concentrations Associated with Timber Fumigation at the Port of Tauranga, New Zealand</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Night-time Stability</strong></td>
</tr>
<tr>
<td>Mr Sullivan would like to further evaluate using real measured temperature profile data evaluate the likelihood of night-time stable conditions occurring and how critical these are to the results.***</td>
</tr>
<tr>
<td>Mr Sullivan would like to further evaluate using real measured temperature profile data evaluate the likelihood of night-time stable conditions occurring and how critical these are to the results.***</td>
</tr>
<tr>
<td><strong>Upset Conditions</strong></td>
</tr>
<tr>
<td>The experts could not identify a scenario that is not captured about the other modelling scenarios and therefore no particular modelling is necessary to assess these. Procedures need to be developed to prevent the repeat of a double ship hold ventilation.</td>
</tr>
<tr>
<td>The experts could not identify a scenario that is not captured about the other modelling scenarios and therefore no particular modelling is necessary to assess these. Procedures need to be developed to prevent the repeat of a double ship hold ventilation.</td>
</tr>
<tr>
<td><strong>Ship hold emissions</strong></td>
</tr>
<tr>
<td>Modelling assuming opening the five holds at two-hourly intervals starting at 10pm, 12am, 2am, 4am, and 6am. The experts agree that the ship hold emissions are unknown and warrant better quantification, namely the absorption rate and the release profile of the emission release over time/hold. In the interim the modelling will assume that 35% of the initial dose is not captured into the hold and is discharged evenly over within the first two hours. And during the next 12 hours 13% is lost by adsorption.</td>
</tr>
<tr>
<td>Modelling assuming opening the five holds at two-hourly intervals starting at 10pm, 12am, 2am, 4am, and 6am. The experts agree that the ship hold emissions are unknown and warrant better quantification, namely the absorption rate and the release profile of the emission release over time/hold. In the interim the modelling will assume that 35% of the initial dose is not captured into the hold and is discharged evenly over within the first two hours. And during the next 12 hours 13% is lost by adsorption.</td>
</tr>
</tbody>
</table>

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*Mr Newenhuis notes that she still considers that there is still value in near field monitoring to assist the modelling analysis.

***The experts agree that these details need to be further refined. Their discussions have been restricted due to time restraints.
ISSUE 5 – Data flow and information sharing

18. The experts have appreciated the opportunity to conference together and have found the process very valuable and constructive. There has been significant progress made on complex matters. There are some residual matters such as ship hold emissions and the exact model settings. The experts have had varying access to the necessary data which is a key factor in the widely different modelling results.

19. The experts request the DMC to consider issuing a further direction to enable additional joint conferencing or conferencing with one another in order to best align future modelling.

REFERENCES

20. We have referred to the following documents in our discussions:

Name of each expert

[Each expert to sign]

David Sullivan,

Aleks Todoroski,

Jennifer Barclay,

Cathy Nieuwenhuijzen
Appendix B: Percentile Output from CALPUFF Across Full Extended Grid Receptor Set
Based on All Hours Modeled
### Table B-1: Percentile Summary Results for the Log Piles

<table>
<thead>
<tr>
<th>Average Period</th>
<th>Percentile</th>
<th>Peak</th>
<th>Year, Julian Day, Start Hour</th>
<th>X [km]</th>
<th>Y [km]</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-HOUR</td>
<td>75.0%</td>
<td>0.0000E+000</td>
<td>2015, 149, 0900</td>
<td>427.690</td>
<td>5331.000</td>
</tr>
<tr>
<td>2-HOUR</td>
<td>75.0%</td>
<td>0.0000E+000</td>
<td>2015, 150, 0900</td>
<td>427.690</td>
<td>5331.000</td>
</tr>
<tr>
<td>3-HOUR</td>
<td>75.0%</td>
<td>0.0000E+000</td>
<td>2015, 151, 0900</td>
<td>427.690</td>
<td>5331.000</td>
</tr>
<tr>
<td>4-HOUR</td>
<td>75.0%</td>
<td>0.0000E+000</td>
<td>2015, 152, 0900</td>
<td>427.690</td>
<td>5331.000</td>
</tr>
<tr>
<td>5-HOUR</td>
<td>75.0%</td>
<td>0.0000E+000</td>
<td>2015, 153, 0900</td>
<td>427.690</td>
<td>5331.000</td>
</tr>
</tbody>
</table>

### Table 4. Percentile Summary Results for the Ships

<table>
<thead>
<tr>
<th>Average Period</th>
<th>Percentile</th>
<th>Peak</th>
<th>Year, Julian Day, Start Hour</th>
<th>X [km]</th>
<th>Y [km]</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-HOUR</td>
<td>75.0%</td>
<td>0.0000E+000</td>
<td>2015, 149, 0900</td>
<td>427.690</td>
<td>5331.000</td>
</tr>
<tr>
<td>2-HOUR</td>
<td>75.0%</td>
<td>0.0000E+000</td>
<td>2015, 150, 0900</td>
<td>427.690</td>
<td>5331.000</td>
</tr>
<tr>
<td>3-HOUR</td>
<td>75.0%</td>
<td>0.0000E+000</td>
<td>2015, 151, 0900</td>
<td>427.690</td>
<td>5331.000</td>
</tr>
<tr>
<td>4-HOUR</td>
<td>75.0%</td>
<td>0.0000E+000</td>
<td>2015, 152, 0900</td>
<td>427.690</td>
<td>5331.000</td>
</tr>
<tr>
<td>5-HOUR</td>
<td>75.0%</td>
<td>0.0000E+000</td>
<td>2015, 153, 0900</td>
<td>427.690</td>
<td>5331.000</td>
</tr>
</tbody>
</table>

---

Dispersion Modeling of Ethanedinitrile Airborne Concentrations Associated with Timber Fumigation at the Port of Tauranga, New Zealand
Table B-2: Percentile Summary Results for the Combination of Piles and Ships

<table>
<thead>
<tr>
<th>Percentile Results Summary</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Average Period</strong></td>
</tr>
<tr>
<td>----------------------------</td>
</tr>
<tr>
<td>1-HOUR</td>
</tr>
<tr>
<td>1-HOUR</td>
</tr>
<tr>
<td>1-HOUR</td>
</tr>
<tr>
<td>1-HOUR</td>
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<tr>
<td>1-HOUR</td>
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<tr>
<td>1-HOUR</td>
</tr>
<tr>
<td>1-HOUR</td>
</tr>
<tr>
<td>1-HOUR</td>
</tr>
<tr>
<td>1-HOUR</td>
</tr>
<tr>
<td>24-HOUR</td>
</tr>
<tr>
<td>24-HOUR</td>
</tr>
<tr>
<td>24-HOUR</td>
</tr>
<tr>
<td>24-HOUR</td>
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<tr>
<td>24-HOUR</td>
</tr>
<tr>
<td>24-HOUR</td>
</tr>
<tr>
<td>24-HOUR</td>
</tr>
<tr>
<td>24-HOUR</td>
</tr>
<tr>
<td>24-HOUR</td>
</tr>
</tbody>
</table>

Table 6. Top-25 Annual Average Concentrations (ppm) for Piles, Ships, and Combination of Both
<table>
<thead>
<tr>
<th>RANKING</th>
<th>PILES</th>
<th>SHIPS</th>
<th>COMBINED</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.00024</td>
<td>0.00005</td>
<td>0.00024</td>
</tr>
<tr>
<td>2</td>
<td>0.00022</td>
<td>0.00004</td>
<td>0.00022</td>
</tr>
<tr>
<td>3</td>
<td>0.00021</td>
<td>0.00004</td>
<td>0.00022</td>
</tr>
<tr>
<td>4</td>
<td>0.00021</td>
<td>0.00004</td>
<td>0.00021</td>
</tr>
<tr>
<td>5</td>
<td>0.00020</td>
<td>0.00004</td>
<td>0.00021</td>
</tr>
<tr>
<td>6</td>
<td>0.00017</td>
<td>0.00004</td>
<td>0.00018</td>
</tr>
<tr>
<td>7</td>
<td>0.00017</td>
<td>0.00004</td>
<td>0.00017</td>
</tr>
<tr>
<td>8</td>
<td>0.00017</td>
<td>0.00004</td>
<td>0.00017</td>
</tr>
<tr>
<td>9</td>
<td>0.00016</td>
<td>0.00004</td>
<td>0.00017</td>
</tr>
<tr>
<td>10</td>
<td>0.00016</td>
<td>0.00004</td>
<td>0.00016</td>
</tr>
<tr>
<td>11</td>
<td>0.00015</td>
<td>0.00003</td>
<td>0.00015</td>
</tr>
<tr>
<td>12</td>
<td>0.00015</td>
<td>0.00003</td>
<td>0.00015</td>
</tr>
<tr>
<td>13</td>
<td>0.00014</td>
<td>0.00003</td>
<td>0.00014</td>
</tr>
<tr>
<td>14</td>
<td>0.00014</td>
<td>0.00003</td>
<td>0.00014</td>
</tr>
<tr>
<td>15</td>
<td>0.00013</td>
<td>0.00003</td>
<td>0.00013</td>
</tr>
<tr>
<td>16</td>
<td>0.00013</td>
<td>0.00003</td>
<td>0.00013</td>
</tr>
<tr>
<td>17</td>
<td>0.00013</td>
<td>0.00003</td>
<td>0.00013</td>
</tr>
<tr>
<td>18</td>
<td>0.00012</td>
<td>0.00003</td>
<td>0.00013</td>
</tr>
<tr>
<td>19</td>
<td>0.00012</td>
<td>0.00003</td>
<td>0.00013</td>
</tr>
<tr>
<td>20</td>
<td>0.00012</td>
<td>0.00003</td>
<td>0.00012</td>
</tr>
<tr>
<td>21</td>
<td>0.00011</td>
<td>0.00003</td>
<td>0.00012</td>
</tr>
<tr>
<td>22</td>
<td>0.00011</td>
<td>0.00002</td>
<td>0.00012</td>
</tr>
<tr>
<td>23</td>
<td>0.00011</td>
<td>0.00002</td>
<td>0.00012</td>
</tr>
<tr>
<td>24</td>
<td>0.00011</td>
<td>0.00002</td>
<td>0.00011</td>
</tr>
<tr>
<td>25</td>
<td>0.00010</td>
<td>0.00002</td>
<td>0.00011</td>
</tr>
</tbody>
</table>

Dispersion Modeling of Ethanodinitril Airborne Concentrations Associated with Timber Fumigation at the Port of Tauranga, New Zealand
Appendix C: Summary of CALPUFF Inputs
### CALPUFF Parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>PUBLIST</td>
<td>CALPUFF output list file (CALPUFF.LST)</td>
<td>CALPUFF.LST</td>
</tr>
<tr>
<td>COMPDAT</td>
<td>CALPUFF output concentration file (COMP.DAT)</td>
<td>COMP.DAT</td>
</tr>
<tr>
<td>ODFDAT</td>
<td>CALPUFF output dry deposition flux file (ODFLX.DAT)</td>
<td>ODFLX.DAT</td>
</tr>
<tr>
<td>WFLDAT</td>
<td>CALPUF output wet deposition flux file (WFLX.DAT)</td>
<td>WFLX.DAT</td>
</tr>
<tr>
<td>LCFILES</td>
<td>Lower case file names (L = lower case; U = upper case)</td>
<td>F</td>
</tr>
<tr>
<td>NMETDOM</td>
<td>Number of CALMET input files</td>
<td>1</td>
</tr>
<tr>
<td>NMBEDAT</td>
<td>Number of CALMET.DAT input files</td>
<td>39</td>
</tr>
<tr>
<td>NNMERRD</td>
<td>Number of RNMERR.DAT input files</td>
<td>0</td>
</tr>
<tr>
<td>NRTD</td>
<td>Number of VRTMERR.DAT input files</td>
<td>0</td>
</tr>
<tr>
<td>NFRDAT</td>
<td>Number of PLEMDAT input files</td>
<td>1</td>
</tr>
<tr>
<td>NREGRID</td>
<td>Number of REGRID input files</td>
<td>0</td>
</tr>
<tr>
<td>NWIN</td>
<td>Number of WIN input files</td>
<td>0</td>
</tr>
<tr>
<td>MREDAT</td>
<td>CALMET grid meteorological data file (CALMET.DAT)</td>
<td>JAN-ME-1.DAT</td>
</tr>
<tr>
<td>METDAT</td>
<td>CALMET grid meteorological data file (CALMET.DAT)</td>
<td>FEB-ME-1.DAT</td>
</tr>
<tr>
<td>METDAT</td>
<td>CALMET grid meteorological data file (CALMET.DAT)</td>
<td>MAR-ME-1.DAT</td>
</tr>
<tr>
<td>METDAT</td>
<td>CALMET grid meteorological data file (CALMET.DAT)</td>
<td>APR-ME-1.DAT</td>
</tr>
<tr>
<td>METDAT</td>
<td>CALMET grid meteorological data file (CALMET.DAT)</td>
<td>MAY-ME-1.DAT</td>
</tr>
<tr>
<td>METDAT</td>
<td>CALMET grid meteorological data file (CALMET.DAT)</td>
<td>JUN-ME-1.DAT</td>
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<td>CALMET grid meteorological data file (CALMET.DAT)</td>
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<td>CALMET grid meteorological data file (CALMET.DAT)</td>
<td>OCT-ME-1.DAT</td>
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<td>METDAT</td>
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<td>NOV-ME-1.DAT</td>
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<tr>
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<td>DEC-ME-1.DAT</td>
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<td>METDAT</td>
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<td>JAN-ME-2.DAT</td>
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<tr>
<td>METDAT</td>
<td>CALMET grid meteorological data file (CALMET.DAT)</td>
<td>FEB-ME-2.DAT</td>
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<td>CALMET grid meteorological data file (CALMET.DAT)</td>
<td>MAR-ME-2.DAT</td>
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<td>APR-ME-2.DAT</td>
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<td>METDAT</td>
<td>CALMET grid meteorological data file (CALMET.DAT)</td>
<td>MAY-ME-2.DAT</td>
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<td>METDAT</td>
<td>CALMET grid meteorological data file (CALMET.DAT)</td>
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### INPUT GROUP: 0 -- Input and Output File Names

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<th>Value</th>
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<tbody>
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<td>NOV-ME-2.DAT</td>
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<td>DEC-ME-2.DAT</td>
</tr>
<tr>
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<td>JAN-ME-3.DAT</td>
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<td>FEB-ME-3.DAT</td>
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<td>MAR-ME-3.DAT</td>
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<td>APR-ME-3.DAT</td>
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<td>MAY-ME-3.DAT</td>
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<td>SEP-ME-3.DAT</td>
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<td>OCT-ME-3.DAT</td>
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<td>DEC-ME-3.DAT</td>
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<td>VOLDAT</td>
<td>Volume source varying emissions file (VOLEMARB.DAT)</td>
<td>VOLEMARB-10X00PP</td>
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<td>M-PFILES.DAT</td>
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### INPUT GROUP: 1 -- General Run Control Parameters

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<th>Description</th>
<th>Value</th>
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<tr>
<td>METRUN</td>
<td>Run all periods in met data file? (0 = no, 1 = yes)</td>
<td>0</td>
</tr>
<tr>
<td>JBYR</td>
<td>Starting year</td>
<td>2014</td>
</tr>
<tr>
<td>JMO</td>
<td>Starting month</td>
<td>1</td>
</tr>
<tr>
<td>JDY</td>
<td>Starting day</td>
<td>1</td>
</tr>
<tr>
<td>JISH</td>
<td>Starting hour</td>
<td>0</td>
</tr>
<tr>
<td>JSMN</td>
<td>Starting minute</td>
<td>0</td>
</tr>
<tr>
<td>JISEC</td>
<td>Starting second</td>
<td>0</td>
</tr>
<tr>
<td>JYR</td>
<td>Ending year</td>
<td>2016</td>
</tr>
<tr>
<td>JMNO</td>
<td>Ending month</td>
<td>12</td>
</tr>
<tr>
<td>JEDY</td>
<td>Ending day</td>
<td>31</td>
</tr>
<tr>
<td>JIHR</td>
<td>Ending hour</td>
<td>23</td>
</tr>
<tr>
<td>JEMIN</td>
<td>Ending minute</td>
<td>0</td>
</tr>
<tr>
<td>JIESEC</td>
<td>Ending second</td>
<td>0</td>
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<tr>
<td>ABTZ</td>
<td>Base time zone</td>
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</tr>
<tr>
<td>NSECCT</td>
<td>Length of modeling time-step (seconds)</td>
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<tr>
<td>NSPEC</td>
<td>Number of chemical species modeled</td>
<td>1</td>
</tr>
<tr>
<td>NSE</td>
<td>Number of chemical species to be emitted</td>
<td>0</td>
</tr>
<tr>
<td>ITST</td>
<td>Stop run after SETUP phase (1 = stop, 2 = run)</td>
<td>2</td>
</tr>
<tr>
<td>MRESTART</td>
<td>Control option to read and/or write model restart data</td>
<td>0</td>
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<tr>
<td>NRESPPD</td>
<td>Number of periods in restart output cycle</td>
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### INPUT GROUP: 1 -- General Run Control Parameters

<table>
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<tr>
<th>Parameter</th>
<th>Description</th>
<th>Value</th>
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<tbody>
<tr>
<td>METFM</td>
<td>Meteorological data format (1 = CALMET, 2 = ISCM, 3 = AUSPLUME, 4 = CTDM, 5 = AERMET)</td>
<td>1</td>
</tr>
<tr>
<td>MPRFFM</td>
<td>Meteorological profile data format (1 = CTDM, 2 = AERMET)</td>
<td>1</td>
</tr>
<tr>
<td>AVET</td>
<td>Averaging time (minutes)</td>
<td>60</td>
</tr>
<tr>
<td>PGTIME</td>
<td>PG Averaging time (minutes)</td>
<td>60</td>
</tr>
<tr>
<td>IOUTU</td>
<td>Output units for binary output files (1 = mass, 2 = odour, 3 = radiation)</td>
<td>1</td>
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### INPUT GROUP: 2 -- Technical Options

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
<th>Value</th>
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<tbody>
<tr>
<td>MGAUSST</td>
<td>Near field vertical distribution (0 = uniform, 1 = Gaussian)</td>
<td>1</td>
</tr>
<tr>
<td>MCTADJ</td>
<td>Terrain adjustment method (0 = none, 1 = ISC-type, 2 = CALPUFF-type, 3 = partial plume path)</td>
<td>3</td>
</tr>
<tr>
<td>MCTSG</td>
<td>Model subgrid-scale complex terrain? (0 = no, 1 = yes)</td>
<td>0</td>
</tr>
<tr>
<td>MSLUG</td>
<td>Near-field puff modeling as elongated slugs? (0 = no, 1 = yes)</td>
<td>0</td>
</tr>
<tr>
<td>MTRANS</td>
<td>Model transitional plume rise? (0 = no, 1 = yes)</td>
<td>1</td>
</tr>
<tr>
<td>MTIP</td>
<td>Apply stack tip downwash to point sources? (0 = no, 1 = yes)</td>
<td>1</td>
</tr>
<tr>
<td>MRSIE</td>
<td>Plume rise module for point sources (1 = Briggs, 2 = numerical)</td>
<td>1</td>
</tr>
<tr>
<td>MTRIP, FL</td>
<td>Apply stack tip downwash to flare sources? (0 = no, 1 = yes)</td>
<td>0</td>
</tr>
<tr>
<td>MRSIE, FL</td>
<td>Plume rise module for flare sources (1 = Briggs, 2 = numerical)</td>
<td>2</td>
</tr>
<tr>
<td>NROW</td>
<td>Building downwash method (1 = ISC, 2 = PRIME)</td>
<td>1</td>
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<tr>
<td>MSHEAR</td>
<td>Treat vertical wind shear? (0 = no, 1 = yes)</td>
<td>0</td>
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<tr>
<td>MSPLIT</td>
<td>Puff splitting allowed? (0 = no, 1 = yes)</td>
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<tr>
<td>MCECHE</td>
<td>Chemical transformation method (0 = not modeled, 1 = MESOPUFF II, 2 = User-specified, 3 = RIVAD/ARM3, 4 = MESOPUFF II for OH, 5 = half-life, 6 = RIVAD with CORROPIA, 7 = RIVAD with CORROPIA, CalTech SOAI)</td>
<td>0</td>
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<tr>
<td>MOCHE</td>
<td>Model aqueous phase transformation? (0 = no, 1 = yes)</td>
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<tr>
<td>MLWC</td>
<td>Liquid water content flag</td>
<td>1</td>
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<tr>
<td>MVET</td>
<td>Model wet removal? (0 = no, 1 = yes)</td>
<td>0</td>
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<tr>
<td>MDRC</td>
<td>Model dry deposition? (0 = no, 1 = yes)</td>
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</tr>
<tr>
<td>MTLT</td>
<td>Model gravitational settling (plume tilt)? (0 = no, 1 = yes)</td>
<td>0</td>
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<tr>
<td>MDISP</td>
<td>Dispersion coefficient calculation method (1 = PROFILE.DAT, 2 = Internally, 3 = PGMMP, 4 = MESOPUFF II, 5 = CTDM)</td>
<td>3</td>
</tr>
<tr>
<td>MTURB</td>
<td>Turbulence characteristic method (only if MDISP = 1 or 5)</td>
<td>3</td>
</tr>
<tr>
<td>MDISP2</td>
<td>Missing dispersion coefficients method (only if MDISP = 1 or 5)</td>
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<tr>
<td>MTAULY</td>
<td>Sigma-y Lagrangian timescale method</td>
<td>0</td>
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<tr>
<td>MTUAUADV</td>
<td>Advective-decay timescale for turbulence (seconds)</td>
<td>0</td>
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<tr>
<td>MCTURB</td>
<td>Turbulence method (1 = CALPUFF, 2 = AERMOD)</td>
<td>1</td>
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<tr>
<td>MRROUGH</td>
<td>PG sigma-y and sigma-z surface roughness adjustment? (0 = no, 1 = yes)</td>
<td>0</td>
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<tr>
<td>MPARTL</td>
<td>Model partial plume penetration for point sources? (0 = no, 1 = yes)</td>
<td>1</td>
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<tr>
<td>MPARTLBA</td>
<td>Model partial plume penetration for buoyant area sources? (0 = no, 1 = yes)</td>
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## INPUT GROUP: 2 – Technical Options

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<th>Description</th>
<th>Value</th>
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<tr>
<td>MTINV</td>
<td>Strength of temperature inversion provided in PROFILE.DAT? (0 = no, 1 = yes)</td>
<td>0</td>
</tr>
<tr>
<td>MPDF</td>
<td>PDF used for dispersion under convective conditions? (0 = no, 1 = yes)</td>
<td>0</td>
</tr>
<tr>
<td>MSGTBL</td>
<td>Sub-grid TBL module for shoreline? (0 = no, 1 = yes)</td>
<td>0</td>
</tr>
<tr>
<td>MBCON</td>
<td>Boundary conditions modeled? (0 = no, 1 = use BCON.DAT, 2 = use CONC.DAT)</td>
<td>0</td>
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<tr>
<td>MSOURCE</td>
<td>Save individual source contributions? (0 = no, 1 = yes)</td>
<td>0</td>
</tr>
<tr>
<td>MFOG</td>
<td>Enable FOG model output? (0 = no, 1 = yes - PLUME mode, 2 = yes - RECEPTOR mode)</td>
<td>0</td>
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<tr>
<td>MREG</td>
<td>Regulatory checks (0 = no checks, 1 = USE PA LRT checks)</td>
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## INPUT GROUP: 3 – Species List

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<tr>
<td>GSPEC</td>
<td>Species included in model run</td>
<td>EDN</td>
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## INPUT GROUP: 4 – Map Projection and Grid Control Parameters

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<th>Value</th>
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<tr>
<td>PMAP</td>
<td>Map projection system</td>
<td>UTM</td>
</tr>
<tr>
<td>FEAST</td>
<td>False easting at projection origin (km)</td>
<td>0.0</td>
</tr>
<tr>
<td>FNORTH</td>
<td>False northing at projection origin (km)</td>
<td>0.0</td>
</tr>
<tr>
<td>JUTMZN</td>
<td>UTM zone (1 to 60)</td>
<td>60</td>
</tr>
<tr>
<td>UTMHEM</td>
<td>Hemisphere (N = northern, S = southern)</td>
<td>S</td>
</tr>
<tr>
<td>RLAT0</td>
<td>Latitude of projection origin (decimal degrees)</td>
<td>0.00N</td>
</tr>
<tr>
<td>RLONG0</td>
<td>Longitude of projection origin (decimal degrees)</td>
<td>0.00E</td>
</tr>
<tr>
<td>XLAT1</td>
<td>1st standard parallel latitude (decimal degrees)</td>
<td>300S</td>
</tr>
<tr>
<td>XLAT2</td>
<td>2nd standard parallel latitude (decimal degrees)</td>
<td>600S</td>
</tr>
<tr>
<td>DATUM</td>
<td>Datum-region for the coordinates</td>
<td>WGS-84</td>
</tr>
<tr>
<td>NX</td>
<td>Meteorological grid - number of X grid cells</td>
<td>237</td>
</tr>
<tr>
<td>NY</td>
<td>Meteorological grid - number of Y grid cells</td>
<td>198</td>
</tr>
<tr>
<td>NZ</td>
<td>Meteorological grid - number of vertical layers</td>
<td>12</td>
</tr>
<tr>
<td>DGRIKX</td>
<td>Meteorological grid spacing (km)</td>
<td>0.18</td>
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<tr>
<td>ZFACE</td>
<td>Meteorological grid - vertical cell face heights (m)</td>
<td>0.0, 20.0, 40.0, 60.0, 80.0, 100.0, 120.0, 140.0, 160.0, 180.0, 200.0, 220.0, 240.0, 260.0, 280.0, 300.0</td>
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<td>XORIGKX</td>
<td>Meteorological grid - X coordinate for SW corner (km)</td>
<td>403.3500</td>
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<tr>
<td>YORIGKX</td>
<td>Meteorological grid - Y coordinate for SW corner (km)</td>
<td>5812.9001</td>
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<td>IBCOMP</td>
<td>Computational grid - X index of lower left corner</td>
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</tr>
<tr>
<td>JBCOMP</td>
<td>Computational grid - Y index of lower left corner</td>
<td>1</td>
</tr>
<tr>
<td>IECOMP</td>
<td>Computational grid - X index of upper right corner</td>
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## INPUT GROUP: 4 -- Map Projection and Grid Control Parameters

<table>
<thead>
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<th>Description</th>
<th>Value</th>
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<tr>
<td>JECOMP</td>
<td>Computational grid - Y index of upper right corner</td>
<td>168</td>
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<tr>
<td>LSAMP</td>
<td>Use sampling grid (gridled receptors) (T = true, F = false)</td>
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<tr>
<td>ISAMP</td>
<td>Sampling grid - X index of lower left corner</td>
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</tr>
<tr>
<td>JSAMP</td>
<td>Sampling grid - Y index of lower left corner</td>
<td>1</td>
</tr>
<tr>
<td>ESAMP</td>
<td>Sampling grid - X index of upper right corner</td>
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</tr>
<tr>
<td>EFSAMP</td>
<td>Sampling grid - Y index of upper right corner</td>
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<tr>
<td>MESHDN</td>
<td>Sampling grid - nesting factor</td>
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## INPUT GROUP: 5 -- Output Options

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<th>Value</th>
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<tr>
<td>ICON</td>
<td>Output concentrations to CONC.DAT? (0 = no, 1 = yes)</td>
<td>1</td>
</tr>
<tr>
<td>IDRY</td>
<td>Output dry deposition fluxes to DFLX.DAT? (0 = no, 1 = yes)</td>
<td>1</td>
</tr>
<tr>
<td>IWET</td>
<td>Output wet deposition fluxes to WFLX.DAT? (0 = no, 1 = yes)</td>
<td>0</td>
</tr>
<tr>
<td>IT2D</td>
<td>Output 2D temperature data? (0 = no, 1 = yes)</td>
<td>0</td>
</tr>
<tr>
<td>RHO</td>
<td>Output 2D density data? (0 = no, 1 = yes)</td>
<td>0</td>
</tr>
<tr>
<td>IVS</td>
<td>Output relative humidity data? (0 = no, 1 = yes)</td>
<td>0</td>
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<tr>
<td>LCOMPRES</td>
<td>Use data compression in output file (T = true, F = false)</td>
<td>T</td>
</tr>
<tr>
<td>IQAPLOT</td>
<td>Create QA output files suitable for plotting? (0 = no, 1 = yes)</td>
<td>1</td>
</tr>
<tr>
<td>IPFTRAK</td>
<td>Output puff tracking data? (0 = no, 1 = yes use timestep, 2 = yes use sampling step)</td>
<td>0</td>
</tr>
<tr>
<td>IMFLX</td>
<td>Output mass flux across specific boundaries? (0 = no, 1 = yes)</td>
<td>0</td>
</tr>
<tr>
<td>IMBAL</td>
<td>Output mass balance for each species? (0 = no, 1 = yes)</td>
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<tr>
<td>INRISE</td>
<td>Output plume rise data? (0 = no, 1 = yes)</td>
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</tr>
<tr>
<td>ICPRTE</td>
<td>Print concentrations? (0 = no, 1 = yes)</td>
<td>0</td>
</tr>
<tr>
<td>IPDRT</td>
<td>Print dry deposition fluxes? (0 = no, 1 = yes)</td>
<td>0</td>
</tr>
<tr>
<td>IPWRT</td>
<td>Print wet deposition fluxes? (0 = no, 1 = yes)</td>
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</tr>
<tr>
<td>ICFRQ</td>
<td>Concentration print interval (timesteps)</td>
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<tr>
<td>IDFQ</td>
<td>Dry deposition flux print interval (timesteps)</td>
<td>1</td>
</tr>
<tr>
<td>IPFQ</td>
<td>Wet deposition flux print interval (timesteps)</td>
<td>1</td>
</tr>
<tr>
<td>IPRTU</td>
<td>Units for line printer output (e.g., 3 = ug/m<strong>3/s, 4 = ug/m</strong>2/s, 5 = odor units)</td>
<td>3</td>
</tr>
<tr>
<td>IMESG</td>
<td>Message tracking run progress on screen (0 = no, 1 and 2 = yes)</td>
<td>2</td>
</tr>
<tr>
<td>LDEBUG</td>
<td>Enable debug output? (0 = no, 1 = yes)</td>
<td>F</td>
</tr>
<tr>
<td>IPFDEB</td>
<td>First puff to track in debug output</td>
<td>1</td>
</tr>
<tr>
<td>NFDEB</td>
<td>Number of puffs to track in debug output</td>
<td>1000</td>
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<td>NFDEB</td>
<td>Starting meteorological period in debug output</td>
<td>1</td>
</tr>
<tr>
<td>NNDEB</td>
<td>Ending meteorological period in debug output</td>
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## INPUT GROUP: 6 -- Subgrid Scale Complex Terrain Inputs

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
<th>Value</th>
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Dispersion Modelling of Ethanedinitrile Airborne Concentrations Associated with Timber Fumigation at the Port of Tauranga, New Zealand
### INPUT GROUP: 6 – Subgrid Scale Complex Terrain Inputs

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<thead>
<tr>
<th>Parameter</th>
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<tr>
<td>NHILL</td>
<td>Number of terrain features</td>
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<tr>
<td>NCTREC</td>
<td>Number of special complex terrain receptors</td>
<td>0</td>
</tr>
<tr>
<td>MTHILL</td>
<td>Terrain and CTSG receptor data format (1 = CTDM, 2 = OPTHILL)</td>
<td>2</td>
</tr>
<tr>
<td>XHILL2M</td>
<td>Horizontal dimension conversion factor to meters</td>
<td>1.0</td>
</tr>
<tr>
<td>ZHILL2M</td>
<td>Vertical dimension conversion factor to meters</td>
<td>1.0</td>
</tr>
<tr>
<td>XCDTMKM</td>
<td>X origin of CTDM system relative to CALPUFF system (km)</td>
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<tr>
<td>YCDTMKM</td>
<td>Y origin of CTDM system relative to CALPUFF system (km)</td>
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### INPUT GROUP: 9 – Miscellaneous Dry Deposition Parameters

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<th>Value</th>
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<tr>
<td>RCUTR</td>
<td>Reference cuticle resistance (s/cm)</td>
<td>30</td>
</tr>
<tr>
<td>RGR</td>
<td>Reference ground resistance (s/cm)</td>
<td>10</td>
</tr>
<tr>
<td>REACTR</td>
<td>Reference pollutant reactivity</td>
<td>8</td>
</tr>
<tr>
<td>NINT</td>
<td>Number of particle size intervals for effective particle deposition velocity</td>
<td>9</td>
</tr>
<tr>
<td>IVEG</td>
<td>Vegetation state in unirrigated areas (1 = active and unstressed, 2 = active and stressed, 3 = inactive)</td>
<td>1</td>
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### INPUT GROUP: 11 – Chemistry Parameters

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</thead>
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<td>MOZ</td>
<td>Ozone background input option (0 = monthly, 1 = hourly from OZONE.DAT)</td>
<td>1</td>
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<tr>
<td>BCKO3</td>
<td>Monthly ozone concentrations (ppb)</td>
<td>80.00, 80.00, 80.00, 80.00, 80.00, 80.00, 80.00, 80.00, 80.00, 80.00, 80.00, 80.00, 80.00</td>
</tr>
<tr>
<td>MINH3</td>
<td>Ammonia background input option (0 = monthly, 1 = from NH3.DAT)</td>
<td>0</td>
</tr>
<tr>
<td>MAVGNH3</td>
<td>Ammonia vertical averaging option (0 = no average, 1 = average over vertical extent of puff)</td>
<td>1</td>
</tr>
<tr>
<td>BCKNH3</td>
<td>Monthly ammonia concentrations (ppb)</td>
<td>10.00, 10.00, 10.00, 10.00, 10.00, 10.00, 10.00, 10.00, 10.00, 10.00, 10.00, 10.00, 10.00</td>
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<tr>
<td>RNTE1</td>
<td>Nighttime SO2 loss rate (%/hr)</td>
<td>0.2</td>
</tr>
<tr>
<td>RNTE2</td>
<td>Nighttime NOx loss rate (%/hr)</td>
<td>2</td>
</tr>
<tr>
<td>RNTE3</td>
<td>Nighttime NO3 loss rate (%/hr)</td>
<td>2</td>
</tr>
<tr>
<td>MH2O2</td>
<td>H2O2 background input option (0 = monthly, 1 = hourly from H2O2.DAT)</td>
<td>1</td>
</tr>
<tr>
<td>BCKH2O2</td>
<td>Monthly H2O2 concentrations (ppb)</td>
<td>1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00</td>
</tr>
<tr>
<td>RH, ISRP</td>
<td>Minimum relative humidity for ISORROPIA</td>
<td>80.0</td>
</tr>
<tr>
<td>SO4, ISRP</td>
<td>Minimum SO4 for ISORROPIA</td>
<td>0.4</td>
</tr>
<tr>
<td>BCKPMF</td>
<td>SOA background fine particulate (ug/m^3)</td>
<td>1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00, 1.00</td>
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### INPUT GROUP: 11 -- Chemistry Parameters

<table>
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<th>Parameter</th>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>OFRAC</td>
<td>SOA organic fine particulate fraction</td>
<td>0.15, 0.15, 0.20, 0.20, 0.20, 0.20, 0.20, 0.20, 0.15</td>
</tr>
<tr>
<td>VCNX</td>
<td>SOA VOC/NOx ratio</td>
<td>50.00, 50.00, 50.00, 50.00, 50.00, 50.00, 50.00, 50.00, 50.00</td>
</tr>
<tr>
<td>NDECA</td>
<td>Half-life decay blocks</td>
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### INPUT GROUP: 12 -- Misc. Dispersion and Computational Parameters

<table>
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<tr>
<th>Parameter</th>
<th>Description</th>
<th>Value</th>
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</thead>
<tbody>
<tr>
<td>SYTDSP</td>
<td>Horizontal puff size for time-dependent sigma equations (m)</td>
<td>650</td>
</tr>
<tr>
<td>MHFTSZ</td>
<td>Use Heffler equation for sigma-z? (0 = no, 1 = yes)</td>
<td>0</td>
</tr>
<tr>
<td>JSUP</td>
<td>PG stability class above mixed layer</td>
<td>5</td>
</tr>
<tr>
<td>CCONK1</td>
<td>Vertical dispersion constant, stable conditions</td>
<td>0.01</td>
</tr>
<tr>
<td>CCONK2</td>
<td>Vertical dispersion constant, neutral/instable conditions</td>
<td>0.1</td>
</tr>
<tr>
<td>TDB</td>
<td>Downwash scheme transition point option (=0 = Huber-Snyder, 1.5 = Schulman-Soper, 0.5 = ISG)</td>
<td>0.5</td>
</tr>
<tr>
<td>IURB1</td>
<td>Beginning land use category for which urban dispersion is assumed</td>
<td>10</td>
</tr>
<tr>
<td>IURB2</td>
<td>Ending land use category for which urban dispersion is assumed</td>
<td>19</td>
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<tr>
<td>ILAND characterize = 20</td>
<td>Land use category for modeling domain</td>
<td>20</td>
</tr>
<tr>
<td>Z0IN</td>
<td>Roughness length for modeling domain (m)</td>
<td>25</td>
</tr>
<tr>
<td>XLAINT</td>
<td>Leaf area index for modeling domain</td>
<td>3.0</td>
</tr>
<tr>
<td>ELEV</td>
<td>Elevation above sea level (m)</td>
<td>0</td>
</tr>
<tr>
<td>XLATIN</td>
<td>Meteorological station latitude (deg)</td>
<td>-999.0</td>
</tr>
<tr>
<td>XLONIN</td>
<td>Meteorological station longitude (deg)</td>
<td>-999.0</td>
</tr>
<tr>
<td>ANEMHIT</td>
<td>Anemometer height (m)</td>
<td>10.0</td>
</tr>
<tr>
<td>ISQVAV</td>
<td>Lateral turbulence format (0 = read sigma-theta, 1 = read sigma-v)</td>
<td>1</td>
</tr>
<tr>
<td>IMIXCTDM</td>
<td>Mixing heights read option (0 = predicted, 1 = observed)</td>
<td>0</td>
</tr>
<tr>
<td>AXLEN</td>
<td>Slug length (met grid units)</td>
<td>1</td>
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<tr>
<td>XSAMLEN</td>
<td>Maximum travel distance of a puffslug (met grid units)</td>
<td>1</td>
</tr>
<tr>
<td>MNXNEW</td>
<td>Maximum number of slugs/puffslugs release from one source during one time step</td>
<td>99</td>
</tr>
<tr>
<td>MXSAM</td>
<td>Maximum number of sampling steps for one puffslug during one time step</td>
<td>99</td>
</tr>
<tr>
<td>NCOVNT</td>
<td>Number of iterations used when computing the transport wind for a sampling step that includes gradual rise</td>
<td>2</td>
</tr>
<tr>
<td>SYMIN</td>
<td>Minimum sigma-z for a new puffslug (m)</td>
<td>1</td>
</tr>
<tr>
<td>SIZMIN</td>
<td>Minimum sigma-z for a new puffslug (m)</td>
<td>1</td>
</tr>
<tr>
<td>SZGCAP_M</td>
<td>Maximum sigma-z allowed to avoid numerical problem in calculating virtual time or distance (m)</td>
<td>50000000</td>
</tr>
<tr>
<td>SVMIN</td>
<td>Minimum turbulence velocities sigma-v (m/s)</td>
<td>0.5, 0.5, 0.5, 0.5, 0.5, 0.5, 0.37, 0.37, 0.37, 0.37, 0.37, 0.37</td>
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### INPUT GROUP: 12 -- Misc. Dispersion and Computational Parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>SWMIN</td>
<td>Minimum turbulence velocities sigma-w (m/s)</td>
<td>0.2, 0.12, 0.08, 0.06, 0.03, 0.016</td>
</tr>
<tr>
<td>CDIV</td>
<td>Divergence criterion for dw/dz across puff (1/s)</td>
<td>0, 0</td>
</tr>
<tr>
<td>LLVM</td>
<td>TBL module search radius (met grid cells)</td>
<td>4</td>
</tr>
<tr>
<td>WSCALM</td>
<td>Minimum wind speed allowed for non-calm conditions (m/s)</td>
<td>0.5</td>
</tr>
<tr>
<td>XMAXZI</td>
<td>Maximum mixing height (m)</td>
<td>3000</td>
</tr>
<tr>
<td>XMINZI</td>
<td>Minimum mixing height (m)</td>
<td>50</td>
</tr>
<tr>
<td>TKCAT</td>
<td>Emissions scale-factors temperature categories (K)</td>
<td>265, 270, 275, 280, 285, 290, 295, 300, 306, 310, 315</td>
</tr>
<tr>
<td>PLX00</td>
<td>Wind speed profile exponent for stability classes 1 to 6</td>
<td>0.07, 0.07, 0.1, 0.15, 0.36, 0.56</td>
</tr>
<tr>
<td>PTG0</td>
<td>Potential temperature gradient for stable classes E and F (deg/Km)</td>
<td>0.02, 0.035</td>
</tr>
<tr>
<td>PPC</td>
<td>Plume path coefficient for stability classes 1 to 6</td>
<td>0.5, 0.5, 0.5, 0.5, 0.5, 0.36, 0.36</td>
</tr>
<tr>
<td>SLSPF</td>
<td>Slug-to-puff transition criterion factor (sigma-y/Slug length)</td>
<td>10</td>
</tr>
<tr>
<td>FCLIP</td>
<td>Hard-capping factor for slugs (0.0 = no extrapolation)</td>
<td>0</td>
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<tr>
<td>NSPLIT</td>
<td>Number of puff created from vertical splitting</td>
<td>3</td>
</tr>
<tr>
<td>RESPLIT</td>
<td>Hour for puff re-split</td>
<td>0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0</td>
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<tr>
<td>ZISPLIT</td>
<td>Minimum mixing height for splitting (m)</td>
<td>100</td>
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<tr>
<td>ROLMAX</td>
<td>Mixing height ratio for splitting</td>
<td>0.25</td>
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<tr>
<td>NSPLTH</td>
<td>Number of puffs created from horizontal splitting</td>
<td>5</td>
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<tr>
<td>SYSPLTH</td>
<td>Minimum sigma-y (met grid cells)</td>
<td>1</td>
</tr>
<tr>
<td>SHSPLTH</td>
<td>Minimum puff elongation rate (SYSPLTH/hr)</td>
<td>2</td>
</tr>
<tr>
<td>CNSPLTH</td>
<td>Minimum concentration (g/m^3)</td>
<td>0</td>
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<tr>
<td>EPSLUG</td>
<td>Fractional convergence criterion for numerical SLUG sampling integration</td>
<td>0.0001</td>
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<tr>
<td>EPSAREA</td>
<td>Fractional convergence criterion for numerical AREA source integration</td>
<td>0.0006</td>
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<tr>
<td>CRSIZE</td>
<td>Trajectory step-length for numerical rise integration (m)</td>
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<tr>
<td>HTMNBC</td>
<td>Minimum boundary condition puff height (m)</td>
<td>500</td>
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<tr>
<td>RSAMPBC</td>
<td>Receptor search radius for boundary condition puffs (km)</td>
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<tr>
<td>MDEPBC</td>
<td>Near-surface depletion adjustment to concentration (0 = no, 1 = yes)</td>
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### INPUT GROUP: 12 -- Point Source Parameters

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<th>Value</th>
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<tr>
<td>NFT1</td>
<td>Number of point sources</td>
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<tr>
<td>IPTU</td>
<td>Units used for point source emissions (e.g., 1 = g/s)</td>
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</tr>
<tr>
<td>NSPT1</td>
<td>Number of source-species combinations with variable emission scaling factors</td>
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### INPUT GROUP: 12 -- Point Source Parameters

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<tr>
<td>NPT2</td>
<td>Number of point sources in PTEMARB.DAT file(s)</td>
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### INPUT GROUP: 14 -- Area Source Parameters

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<td>NAR1</td>
<td>Number of polygon area sources</td>
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<tr>
<td>IARU</td>
<td>Units used for area source emissions (e.g., 1 = g/m**2/s)</td>
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<tr>
<td>NSAR1</td>
<td>Number of source-species combinations with variable emission scaling factors</td>
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<tr>
<td>NAR2</td>
<td>Number of buoyant polygon area sources in BAEMARB.DAT file(s)</td>
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### INPUT GROUP: 15 -- Line Source Parameters

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<tbody>
<tr>
<td>NLN2</td>
<td>Number of buoyant line sources in LINEMARB.DAT file</td>
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</tr>
<tr>
<td>NLINES</td>
<td>Number of buoyant line sources</td>
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<tr>
<td>ILNU</td>
<td>Units used for line source emissions (e.g., 1 = g/s)</td>
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</tr>
<tr>
<td>NSLN1</td>
<td>Number of source-species combinations with variable emission scaling factors</td>
<td>0</td>
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<tr>
<td>NLRISE</td>
<td>Number of distances at which transitional rise is computed</td>
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### INPUT GROUP: 16 -- Volume Source Parameters

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<th>Value</th>
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<tbody>
<tr>
<td>NVL1</td>
<td>Number of volume sources</td>
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</tr>
<tr>
<td>IVL1</td>
<td>Units used for volume source emissions (e.g., 1 = g/s)</td>
<td>1</td>
</tr>
<tr>
<td>NSVL1</td>
<td>Number of source-species combinations with variable emission scaling factors</td>
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<tr>
<td>NVL2</td>
<td>Number of volume sources in VOLEMARMB.DAT file(s)</td>
<td>41</td>
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### INPUT GROUP: 17 -- FLARE Source Control Parameters (variable emissions file)

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<th>Value</th>
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<tr>
<td>NFL2</td>
<td>Number of flare sources defined in FLEMARMB.DAT file(s)</td>
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### INPUT GROUP: 18 -- Road Emissions Parameters

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<td>NRD1</td>
<td>Number of road-links sources</td>
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</tr>
<tr>
<td>NRD2</td>
<td>Number of road-links in RDEMARMB.DAT file</td>
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<tr>
<td>NSFRLDS</td>
<td>Number of road-links and species combinations with variable emission-rate scale factors</td>
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### INPUT GROUP: 18 -- Emission Rate Scale-Factor Tables

<table>
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<tbody>
<tr>
<td>NFSFTAB</td>
<td>Number of emission scale-factor tables</td>
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</tr>
</tbody>
</table>
Appendix D: 2019 Port Fumigation Records Based on Methyl Bromide Fumigation

Documentation for Calendar Year 2019

These files will be made available upon request.
Appendix E: Model Input / Output Files Available in Electronic Format

These files will be made available upon request.
Appendix F: Greater Resolution Isopleth Analyses for the Evaluation of Worker Exposure

This appendix presents close up isopleth analyses of the maximum impacts at the port area for averaging times of 1, 8, and 24 hours based on the composite ships and log stacks analysis. Review of these figures shows that with the exception of the 24-hour endpoint of 0.034 ppm, none of the health endpoints are reached beyond the immediate application areas. For 24-hour exposures, which would be applicable at the port boundary, the modeled results are well below the health endpoint of 0.034 ppm.
Figure F-1: Close-Up Isopleth Analysis of Maximum Impact Area of 1-Hour Averaging Based on the Combined Ship and Log Stack Sources Based on the 100th Percentile (ppm)

Note: the health endpoint of 2 ppm is not shown beyond the immediate application area.
Figure F-2: Close-Up Isopleth Analysis of Maximum Impact Area for 8-Hour Averaging Based on the Combined Ship and Log Stack Sources Based on the 100th Percentile (ppm)\textsuperscript{14}

\textsuperscript{14} Note: the health endpoint of 3 ppm is not shown beyond the immediate application area.
Figure F-3: Close-Up Isopleth Analysis of Maximum Impact Area for 24-Hour Averaging Based on the Combined Ship and Log Stack Sources Based on the 100<sup>th</sup> Percentile (ppm)<sup>15</sup>

Note: the health endpoint of 0.034 ppm is applicable to locations at and beyond the fence line.
Figure F-4: Close-Up Isopleth Analysis of Maximum Impact Area for 1-Hour Averaging Based on the Combined Ship and Log Stack Sources with the Ship Berth Areas Highlighted Based on the 100th Percentile (ppm)\textsuperscript{16}

\textsuperscript{16} The maximum 1-hour concentration near the ship area is <=0.67 ppm
Figure F-5: Close-Up Isopleth Analysis of Maximum Impact Area for 8-Hour Averaging Based on the Combined Ship and Log Stack Sources with the Ship Berth Areas Highlighted (Based on the 100th Percentile ppm)
Figure F-6: Close-Up Isopleth Analysis of Maximum Impact Area for 24-Hour Averaging Based on the Combined Ship and Log Stack Sources with the Ship Berth Areas Highlighted Based on the 100th Percentile (ppm) \(^{17}\)

\(^{17}\) Maximum modeled 24-hour concentrations near the ships is $$\leq 0.043$$ ppm.