Review of Assessment for Environmental Effects for the Potential Air Quality Effects Associated with the Operation of Processing Crude Tall Oil and Crude Sulphate Turpentine from Lawter NZ Ltd, at 211 Totara Street, Mount Maunganui, New Zealand

Attention:

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Executive Summary

ASG has been engaged by Bay of Plenty Regional Council to conduct a review of a qualitative and dispersion modelling study of the emissions to air from Lawter NZ Limited (Lawter). Golder Associates NZ Limited (Golder) and Tonkin and Taylor (T&T) were engaged by Lawter to prepare a technical assessment of potential air quality effects associated with the operation of processing crude tall oil (CTO) and crude sulphate turpentine (CST) at 211 Totara Street, Mount Maunganui, Tauranga. The Assessment of Environmental Effects (AEE) was to accompany a Resource Consent application by Lawter to continue its existing operation.

Lawter operates a chemical manufacturing plant which processes Crude Tall Oil (CTO) and Crude Sulphate Turpentine (CST) at 211 Totara Street, Mount Maunganui. Lawter has the capacity for processing up to 16,000 tonnes of CTO and 5,000 tonnes of CST per year. From these inputs, the site produces a wide range of products, including resins, Tall oil fatty acids, distilled tall oil, pine oil, dependence and myrcene. By products and residues from the processes are combusted in furnaces to provide heat for distillation and other processes.

The AEE considered the potential effects from the discharges of contaminants from;

- The combustion emissions from two high temperature (HT) furnaces, (hereafter called HT furnaces),
- Odour associated with the manufacturing processes, and
- Visible plumes arising from the high temperature furnaces.

The AEE conducted dispersion modelling to assess the effects of Particulate Matter PM_{10} and $PM_{2.5}$, and deferred to the BOPRC ASG reports for SO_2 modelling. With regards to odour and visible plume discharges, the assessment approach was based on consideration of the Best Practicable Option (BPO) for minimising odour and visible plume.

There are multiple contaminants discharged to air from the HT furnaces including PM_{10} and $PM_{2.5}$, SOx, NOx, CO and VOCs, but only PM was modelled as it was generally agreed that the other products of combustion were sufficiently low as to likely have negligible effects. The NOx emissions were modelled as part of this review and it was concluded that the predicted concentrations of NO_2 were minor. It has been recommended that Lawter conduct in-line PM monitoring and consider placing a $PM_{2.5}$ monitor within 400m of the HT furnaces.

Odour is a significant problem for Lawter and complaints occur fairly regular. Odours are likely to be an ongoing challenge for the plant due to their fugitive nature arising from most plant processes including the raw materials received on site, and the final products produced. At the time of writing this report Lawter has made no decisions on odour mitigation of the waste gases if the HT furnaces are not operating.

Lawter has had complaints of visible plumes. Black smoke is most likely to occur from the HT furnaces if the fuel and air are not in balance, or the rules of combustion have not been satisfied. Although Lawter currently control the combustion process through managing O_2 and CO_2, and have recently installed cameras, the frequently interrupted HT furnaces, and the types of CST they receive suggest ongoing difficulties in managing visible plumes. Mitigation against visible plumes will require stringent management practices to remain within the consent conditions which control time and obscuration of the plumes, where a new limit of 20% obscuration is recommended.

Of the air pollutants that Lawter produces by far the most problematic is discharges of SO_2 and is the most focus of the two AEEs. Lawter currently holds resource consent (61693-AP) from the BOPRC. The consent was issued in 2005 and transferred to Lawter in 2011. Lawter is seeking to continue discharging contaminants into the air from its existing operation. Currently the Lawter consent permits them to release up to 74 kg/hr SO_2. This consent expires on 30 June 2020. The AEE are supportive of this current maximum limit, believing that because SO_2 emission rates are continuously monitored if any SO_2 spikes are detected the site operator would stop or reduce the feed or adjust the fuel. The AEE considers that these mitigation measures are appropriate to ensure SO_2 emission rates can be maintained within the consent limit. In addition to this, Golder has suggested an additional percentage limit of 5-10% of time that the emission can be up to 74 kg/hr and have suggested an emission limit of 40-50 kg/hr for 90 to 95% of the time. T&T have suggested an emission limit of 50 kg/hr for 75% of the time.

This review through analysis of the current operations of the Lawter plant since 2014 has shown that the AEE recommendations are unwarranted and are far beyond where the plant is currently operating. Further, these allowances have not been modelled as the BOPRC\ASG CEM modelling was conducted on much lower actual operating emissions.

Dispersion modelling which is reliable indicator of ground level concentrations for the HT furnaces has shown that significant SO_2 exceedances occur well beyond the plant boundary at both 74 kg/hr and > 58 kg/hr, when assessed alone, and therefore, does not support a maximum upper limit > 58 kg/hr. In other words the effect of Lawter operating at a discharge > 58 kg/hr will result in significant exceedances of the 1-hour maximum NES beyond the plant boundary, when assessed alone. Therefore, the following minimum discharge limits are tentatively recommended as they are based primarily on actual operations and dispersion modelling and have not taken into consideration cumulative effects, or, other important considerations such as feasibility and cost. Therefore, Lawter will need to find acceptable limits that takes into consideration; dispersion modelling, current operations, cost, environmental benefits, feasibility and cumulative impacts.

The following discharge limits are the minimum that are recommended;
New maximum upper limit of 58 kg/hr

Secondary emission limits of	50 – 58 kg/hr for 1% of the time (87 hrs)
	40 – 50 kg/hr for 3% of the time (262 hrs)
	< 40 kg/hr for 96% of the time

A cumulative assessment has shown that Lawter will need to reduce its SO_2 discharge to 40 kg/hr in conjunction with emission reductions from other nearby industry in order that there are no significant exceedances beyond any of the plant boundaries.

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1. Introduction

1.1 Overview

Lawter operates a chemical manufacturing plant which processes crude tall oil (CTO) and crude sulphate turpentine (CST) at 211 Totara Street, Mount Maunganui, Tauranga. Lawter has the capacity for processing up to 16,000 tonnes of CTO and 5,000 tonnes of CST per year. From these inputs the site produces a wide range of products, including resins, tall oil fatty acids, distilled tall oil, pine oil, Dipentene, and Myrcene. By products and residues from the processes are combusted in furnaces to provide heat for distillation and other processes. Lawter holds resource consent (61693-AP) from the Bay of Plenty Regional Council (BOPRC), which authorises the discharges to air from this site. The consent was issued in 2005 and transferred to Lawter in 2011. The current discharge expires on the 30 June 2020.

Lawter are seeking to continue discharging contaminants into the air from its existing operation and have engaged technical assistance to assess the potential air quality effects on the environment associated with the operation of processing CTO and CST. Two 'Assessment of Environmental Effects' (AEE) have been prepared by Golder Associates NZ Limited[1] in August 2019, and by Tonkin and Taylor Limited[2] in December 2019. These documents are referred to as 'the AEE' or specifically 'the Golder AEE' or 'the T&T AEE' in this review.

1.2 Potential Air Discharges

The AEE considered the potential effects from the discharges of contaminants from;

- The combustion emissions from two high temperature (HT) furnaces, (hereafter called HT furnaces),
- Odour associated with the manufacturing processes, and
- Visible plumes arising from the high temperature furnaces.

According to the AEE air pollutants are produced in multiple processes, these are briefly explained below for clarity.

<u>CTO Plant</u> – Several waste streams are generated within the CTO plant, described as 'head' and 'pitch'. Some streams are sent to the Fuel A tank to be stored as Fuel which is then burnt by the HT furnaces. Pitch is sent from the CTO plant to a storage tank from where it can be sent to the Fuel A tank for burning in the HT furnaces, or sent to a Resin Plant reactor for drumming and sale. All non-condensable gases from the CTO plant are extracted by a waste gas system and incinerated in one of the HT furnaces.

<u>CST Plant</u> – The CST plant has four sections; the CST distillation, crude pine oil (CPO) manufacture, CPO distillation, and the myrcene plant. Sulphurous compounds are created in the CST distillation which are either collected and discharged into a waste water tank or sent to the HT furnaces along

[1] Technical Air Quality Assessment. Lawter NZ Limited. Submitted to Lawter by Golder, August 2019
[2] Air Discharge Re-consenting. Assessment of Environmental Effects. Submitted to Lawter by Tonkin and Taylor, December 2019.

with the non-condensable waste gases. Non-condensable gases from the CST distillation processes are extracted by the waste gas system and incinerated in one of the HT furnaces.

This plant uses continuous multi column distillation to recover TOFA, DTO and Rosin. The plant is made up of 5 continuous stages of which three are distillation columns. The 5 stages are; dehydration, where water and volatiles are removed to produce dehydrated tall oil; de-pitching, where non-volatile materials are removed to produce depitched tall oil, generating a residue stream that contains pitch, a waste product.

Resin plant – Non-condensable gases from the resin reactors are extracted by a waste gas system and sent to the HT furnaces for destruction. Air is extracted from the Rotoformer line to minimise odour in the Rotoformer room. The extracted air is passed through a cyclone to remove dust and then treated in a biofilter. Air is collected from the Rotoformer bagging area and passed through a bag filter.

Material storage, loading and unloading – raw materials, finished products, intermediate products and waste water effluent is stored in the drum storage areas and bulk storage tanks in the tank farms. Raw CTO and CST sourced from Kraft pulp mills and overseas are delivered by tanks and transferred to the onsite storage via hoses. Following emptying, the tanks are washed and flushed water is discharged to the wastewater tank. The CTO mix tank, fuel tanks and CST storage are kept under vacuum and the gases from the tanks are extracted to the HT furnaces for destruction. Some waste stream storage tanks and those associated with resin production and CST distillation are kept under negative pressure and the headspace vapours are extracted to the HT furnaces for destruction.

Wastewater and effluent treatment – the wastewater tank located at the CST plant receives waste streams from; CST distillation heads; CST desulphurisation wastewater; CTO ejector water; CST and CTO distillation flush water for maintenance; beta-pinene desulphurisation wastewater; wastewater from effluent tank; waste water from the CST process area, and; condensations collected from the wate gas line. The wastewater is stored and accumulated in the waste water tank. The bottom aqueous layer which contains a high concentration of sulphur is burnt in the HT furnaces. The wastewater tank is kept under vacuum and has headspace vents extracted to the HT furnaces through the waste gas extraction system.

HT Plant – This plant is comprised of two high temperature furnaces which are designed to burn natural gas, by products (Fuel A), or a blend of these. The HT plant is equipped with real time monitoring system, which measures SO_2 discharge rates and concentrations, O_2 and CO levels and exhaust flow rate. The main function of this plant is to provide heat to the plant heating medium and to generate the site steam which heats the CST/CPO/Myrcene plants. The HT furnaces also burn non-condensable gases extracted from the CTO, CST and resin plants, from the storage tanks vents and from the aqueous layer of the wastewater.

1.3 Consenting History

The current Resource consent 61693-AP was granted by BOPRC on the 30 November 2005 and is set to expire on the 30 June 2020. The current consent authorises discharges to air associated with the operation of the CST plant and CTO refining plants, HT Plant, the resin manufacturing plant and the myrcene plant. In addition, the consent authorises the discharge of odour from the Lawter site. Key conditions of the Lawter 61693-AP consent are as follows;

Table 1-1. Key conditions of resource consent 61693-AP.

Purpose	Key Conditions
Discharge PM, odorous gases, combustion gases and volatile organic compounds to air	5.1 The HT furnaces and myrcene pyrolysis furnace shall be operated by the permit holder in a manner such that any smoke emission from the stack, after a 15-minute start up period, when smoke shall be kept to a minimum, shall not exceed 40% obscuration determined visually, for any continuous period of one minute in an hour or in total two minutes in an hour
	5.2 The mass discharge of PM from the combined HT furnaces shall not exceed 3.2 kg/hr
	5.3 The permit holder shall ensure that the mass discharge of SO_2 from the combined HT furnace stack does not exceed 74 kg/hr
	6.1 The permit holder shall operate all equipment and manage on-site activities in a manner that ensures that all objectionable or offensive odour does not occur beyond the boundary of the site
	6.7 All vapours from liquid raw material tanks, all of the off-gases from the distillation columns and vapours from the product tanks shall be collected and burned by the permit holder in both HT furnaces unless they are unable to be used.
	7.1.1 The permit holder shall undertake monitoring of the indicators of combustion conditions in both of the HT furnaces including continuous monitoring of - combustion gas temperature at the end of pass 2, - CO and O_2 concentration
	7.1.2 The permit holder shall undertake monitoring of the operation of the bag filter on the resin Rotoformer line to ensure it is operating correctly (reducing PM discharges), by visually assessing the discharge point for particulate presence and checking the general operation of the filter before the daily commencement of operation
	7.1.3 The permit holder shall undertake monitoring of the combined emissions from the High Temperature furnaces every six months during times that sulphur containing fuels and pitch are being burned to determine the flue gas velocity, concentration and mass emission of particulate matter using manual velocity measurement.
	7.1.4 The permit holder shall undertake monitoring of the combined emissions from the HT furnaces every 3 months for the first year from the commencement of this consent during times that sulphur containing fuels and pitch are being burned, such as during a 1st pass distillation, to determine the concentration and mass emission of sulphur dioxide.

1.3.1 Compliance History

BOPRC have undertaken two scheduled compliance audits since the beginning of 2016, i.e., one in 2016 and one in 2019. The first inspection found the site in a moderate level of non-compliance. There were issues surrounding an odour complaint in May 2016 as well as non-provision reports required by 61693-AP as well as gaps in data provision. This reporting and data provision has since been provided. The 2019 inspection also found the site in a moderate level of non-compliance. Non-compliance alluded to several odour complaints received from the public as well as visible plume discharges and other general complaints.

Since December 2017 twenty eight complaints were received by BOPRC[3], twenty two related to odour (five of them in the period January to April 2020). The remainder were due visual plumes from the HT furnace stack and other general complaints relating to air quality. Lawter were issued an abatement notice on 11 February 2019 associated with an offensive odour. On 19 May 2019, Lawter received an additional abatement notice for a calculated exceedance of 81 kg/hr, which was later withdrawn due to a faulty flow meter. Two other incidents which were not included in the BOPRC complaint list include an incident on the 9 December 2019 and one on the 25 December 2019.

On the 9 December 2019 there was a product spill on the Lawter site. Two complaints were received on the pollution hotline regarding an odour coming from the Lawter resin manufacturing plant located at 211 Totara Street, Mount Maunganui. Approximately 22,000 litres of alpha pinene/beta pinene product was discharged into a containment bund while work was being undertaken on a fitting at the base of the storage tank. Council staff attended the incident however due to the site being classified as a major hazard facility Fire and Emergency New Zealand took control of the site to manage the potential fire risk. All spilt product including water and foam was contained and transferred to onsite storage tanks. None of the spilt product or firefighting water/foam was discharged to trade waste or the storm water system.

On the 25 December 2019 an odour complaint was received on the pollution hotline regarding an odour coming from the Lawter resin manufacturing plant. At the time of the complaint the facility was shut down for Christmas and the tank farm waste gas was being managed through the bio-filter bed. Council staff requested the assistance of Fire and Emergency New Zealand to manage the incident. After the issue was brought to Lawter's attention staff the plant was restarted and the scrubber was used to manage the waste gases while the bio filter bed was reinstated. An incident investigation report was subsequently provided to the Council outlining the issue, solutions and investigating the potential for onsite perimeter gas monitoring.

1.4 Pollutants Assessed in the AEE

The AEE pointed out that the key contaminants discharged from the HT furnaces are SO_2 and, to a lesser extent, particulate matter, PM_{10} and $PM_{2.5}$ and nitrogen oxides NO_2. The AEE modelled PM from the high temperature furnaces using BOPRC\ASG the 2014-2016 meteorological model which was developed for the TMMA and detailed in ASG 2018a[4], 2018b[5]. The AEE did not model SO_2 preferring to utilise the SO_2 modelling results detailed in the BOPRC\ASG reports ASG 2018c[6], ASG 2018d[7]. Pollutants, NOx, PM from the myrcene plant were not modelled as their emissions were

[3] BOPRC 61693-AP Complaints.
[4] Report 1 – Meteorological Modelling and Analysis ASG Barclay 2018.pdf
[5] Report 1 – Appendices for Meteorological Modelling and Analysis ASG Barclay 2018.pdf
[6] Report 3 – Continuous Emission Modelling CEM and other SO2 Sources ASG Barclay 2018.pdf
[7] Report 2 – Industrial Maximum Emission Limits Modelling MEL ASG Barclay 2018.pdf

expected to be very low. Dust emissions from the Resin plants pastillation line (Rotoformer line) were considered minimal and were also not included in the assessment.
Odour and visible plume discharges was based on a consideration of best practicable options.

ASG has conducted a review of the potential pollutants to air in the following sections

Section 2	Review of Combustion Emissions (excluding SO_2)
Section 3	Review of Odours
Section 4	Review of Visible Plumes
Section 5	Review of Sulphur Dioxide
Section 6	Discussion and Conclusions

2. Review of Combustion Emissions (excl SO_2)

A review of the combustion gases is discussed below in point form with the comments below each statement. A summary statement at the end of this section provides an overview of the findings.

The primary combustion activities that discharge contaminants into the air from the Lawter facility are;

- Combustion of waste gases, wastewater and natural gas by the two high temperature furnaces
- Combustion of natural gas by the myrcene pyrolyser burner

The waste streams, Fuel A and natural gas that are burned in the HT furnaces contain organic and sulphur compounds. The HT plant gives rise to hot exhaust streams including gases and particulates. The major proportion of the gaseous emissions consist of nitrogen (N_2), Oxygen (O_2), carbon dioxide (CO_2) and water vapour. The flue gases also contain other products of combustion including PM_{10} and $PM_{2.5}$, SOx, NOx, CO and VOCs. The AEE only considered discharges of the primary pollutants from the HT furnaces which were PM_{10}, $PM_{2.5}$, SO_2 and NOx. The other products of combustion were considered to be sufficiently low to have a negligible effect and therefore were not assessed further.
Comment. ASG agrees with the AEE that the other products of combustion are likely to be low. The AEE has focussed in the primary air quality impacts which are SO_2, PM, odour and visible plumes.

Section 2.3 of Golder AEE. Topography and Meteorology.
The AEE utilised the BOPRC ASG developed three-dimensional meteorological data for PM modelling which has been evaluated, therefore the meteorology is not discussed further.

Section 2.4.1 of Golder AEE. Discharges of PM in TMMA
Golder state that discharges of PM are from neighbouring industrial sites within 1km of the Lawter site. PM is from manufacture of fertiliser and animal feeds and from the combustion of natural gas/fuel oil for burners/heaters. Further, the AEE identified Tauranga airport as another significant source of PM_{10} and $PM_{2.5}$.
Comment. Within the TMMA the main dischargers of PM_{10} are domestic heating which accounts for 40%, approximately 19% is from industry, and 18% is from shipping. The main dischargers of $PM_{2.5}$ is shipping which contributes about 22% to the annual average $PM_{2.5}$ and 9% from industry[8].

Section 3.1 of Golder AEE. PM_{10} Figure 6, Figure 7 and Figure 8.
According to the AEE high PM events are not caused by Lawter because the wind is not blowing the right way. Three exceedances of the 24-hour NES PM_{10} (50 µg/m^3) occurred at the Marae monitor in 2018. There were no exceedances of the 24-hour NES at either Bridge Marina or Totara Street monitors. Plots of the 1-hour PM_{10} concentrations against wind direction measured at the three monitoring sites are shown in Figure 6 to Figure 8 of the Golder AEE.

The AEE makes the point that when the wind blows towards the Marae from the HT furnaces in the wind range 30º – 60º, the 1-hour PM_{10} concentrations were significantly lower (average of 21µg/m^3, maximum of 56 µg/m^3 and 95th percentile of 37 µg/m^3) than when the wind blows from the direction

[8] E. Wilton. BOPRC Tauranga Air Emission Inventory, 2018. Environet

of either Ballance or WMNZ. According to Golder this means the exceedances were likely caused by PM_{10} from Ballance and WMNZ, and not Lawter, as per the statement below;

'*which indicated that Ballance was likely to be a contributor to these exceedances'*.

The AEE continue to use the same argument when discussing the contributions from Totara street (Figure 7) which shows wind direction bins separated according to facility. According to the AEE, all PM_{10} in the category 245º to 360º are downwind of the Port, and therefore, from the Port.
Comment. This is a very simplistic argument**.** Golder have solely used the hourly wind direction to determine whether they believe Lawter contributed to PM exceedances at the Marae monitor or not. The AEE uses a similar argument to explain high concentrations at the BOPRC Totara monitor. However, unfortunately, this is neither a true or reasonable argument as the wind direction is constantly oscillating by 30º - 50º and, more so, when the winds are light. This means that Lawter is likely contributing to concentrations at the monitor for any northerly or easterly moderate winds. In light winds the HT furnace contribution could be from any wind direction. Therefore, wind direction is a guide to a facility contribution only.

Because of the nearness of the three main industrial sites, Lawter, Ballance and WMNZ, the contribution of PM at the monitoring sites (Marae, Bridge marina and Totara) are most likely the combined contribution of all three industrial plumes in light to moderate winds, regardless of wind direction.

In light winds (< 3.3 m/s) which occur for approximately 48% of the time wind direction will oscillate through 360 degrees. This means that the PM in the wind direction range of 245º to 360º which the AEE has assigned to be from the Port is actually the combined contribution of all industrial facilities, the port, domestic heating etc.

Section 3.1 Golder AEE. PM_{10} concentrations from Totara Street are representative of Background of the Port, while those monitored at the Marae monitor are representative of Background from the industry.
The AEE considers the PM_{10} concentrations measured at Totara Street are expected to represent background PM_{10} as they are representative of PM near the Pot of Tauranga, while those monitored at the Marae are more representative of the background level near the industrial sites.
Comment. This is a fair assessment for background. Totara street monitoring station is more representative of the port activities, traffic and domestic heating and is less representative of industry than the Marae monitor which is especially biased to the emissions from Ballance.
The AEE has used the follow background values;

- PM_{10} (24-hour): the measured 95th percentile 24-hour PM_{10} concentration at the Marae monitor (36 µg/m^3)
- PM_{10} (annual): the measured average 24-hour PM10 at the Marae monitor (18.6 µg/m^3)
- $PM_{2.5}$ (24-hour): the measured 95th percentile 24-hour PM2.5 from Totara (13 µg/m^3)
- $PM_{2.5}$ (annual): the measured average 24-hour PM2.5 from Totara (7 µg/m^3)

There is some double counting of PM as a part of the contribution already in the background is from Lawter itself as well as Ballance, but the AEE usage of 36 µg/m^3 is in a similar ball park to that of the

Ministry for the Environment (MfE 2016) recommended tool (NZTA 2014) which recommends a 24-hour average PM_{10} background concentration of 33 µg/m^3 for the Mt Maunganui industrial area. But, including background is not the same as assessing the cumulative contribution within the TMMA. The AEE should have taken into consideration the cumulative impacts which should include;

Industrial emissions, i.e., modelled contribution from Ballance, WMNZ + Background (airport, port, traffic, domestic heating etc) + modelled contribution from itself (Lawter).

Modelling should be conducted that shows emissions from all the co-located industrial sites to Lawter which include Ballance and WMNZ + Background (Totara street or that recommended by MfE of 33 µg/m^3) + Lawter. The result from this modelling would most likely show exceedances, partly due to the double counting of the industrial emissions in the MfE background data. Another way to model this would be to use lower background values say from BOPRC Otumoetai station which does not explicitly include the industrial emissions, but still captures, traffic, domestic heating and the port operations.

There is significant merit in modelling the combined industrial contribution of PM as exceedances have been recorded at the Marae monitor on three occasions. The AEE does not believe that Lawter contributed significantly to these exceedances. However, to eliminate Lawter from contributing to these exceedances is virtually impossible unless they were non-operational at the time. A much more accurate way to assess the HT furnace contribution is to consider through dispersion modelling the Lawter emission contribution to a model exceedance and if its contribution is > 4% then it is contributing toward that exceedance. Since modelling shows that on its own Lawter is predicting maximum off-site 24-hour PM_{10} and $PM_{2.5}$ of 12% and 24% of the NES then it is most likely is contributing toward the measured exceedances.

Model Results. Section 7.2 of T&T AEE

On its own, Lawter predicted maximum off-site 24-hour average PM_{10} and $PM_{2.5}$ concentrations of 6 µg/m^3, which was 12% and 24% of their respective assessment standards. At the Marae monitor the 24-hour average was 5 µg/m^3. The annual PM_{10} and $PM_{2.5}$ concentrations were 1 µg/m^3 and 0.3 µg/m^3, respectively. However, when background was included into the modelling results, the results were significantly higher. For instance;

- 24-hour PM_{10} was 84% of criterion
- Annual PM_{10} was 98% of criterion
- 24-hour $PM_{2.5}$ was 76% of criterion
- Annual $PM_{2.5}$ was 80% of criterion

These results include background PM based on the 95th percentile limits from the measured data at the Marae monitor and Totara monitor. As pointed out above, these results exclude other nearby industry (Ballance and WMNZ) which should have been explicitly accounted for, and, the AEE has over weighted the actual background (as it already contains a proportion of industry, including some double counting of Lawter itself). The choice of the 95th percentile limit (438th highest) for background has reduced the industrial contribution to a degree, but the end result is that the predicted model concentrations are likely lower than they would be had the AEEs considered**;**

Specific other Industry contribution + Background (excl nearby industry) + facility (Lawter)

Instead of;

No other industry contribution + Background (95th % includes some industry) + facility (Lawter)

Section 3.2 Golder AEE. $PM_{2.5}$. Table 3 and Figure 9, Figure 10. Plots of 24-hour and 1-hour $PM_{2.5}$ from Totara Street monitor from August 2018 – August 2019.
Golder uses the same argument with respect to wind direction to point out that $PM_{2.5}$ concentrations were higher from Ballance and the Port of Tauranga than those measured when Lawter and other sites were upwind of the monitor.
Comment. ASG disagrees that Lawter contribution can be assessed purely by wind direction. The AEE states that the $PM_{2.5}$ concentrations are higher when other industrial sources were upwind. But, actually the key point of Figure 9 should have been to show that $PM_{2.5}$ is mostly more than 50% of the WHO limit of 25 µg/m³ and that the data is mostly evenly spread in the 8 µg/m³ to 12 µg/m³ range over the entire year.

Table 4.4. T&T AEE. Proposed New PM Standards
Table 4.4 does not mention the new proposed Ministry for the Environment $PM_{2.5}$ standards. They are the same as the WHO standards in the table, but should be included and referenced in the table.

Section 5.2.1.2 PM_{10}. Lawter has conducted PM_{10} emission testing from the high temperature furnaces between 2013 and 2018. The results were routinely below the consent limit of 3.2 kg/hr, where May 2013 recorded the highest value of 2.9 kg/hr.
Comment. Golder used the PM_{10} consent limit of 3.2 kg/hr as the emission rate for modelling which is appropriately conservative.

Section 5.2.1.3 NOx. The NOx emissions from the high temperature furnaces has been estimated based on the US EPA AP-42 emission factors for waste oil (US EPA 1997 – Table 1.11-2). According to the AEE the emission factor of 19 lb/103 gal (2.28 kg/m³) of waste oil is burned. This resulted in a NOx emission rate of 0.6 g/s. The AEE did not model for NOx as emissions were expected to be less than minor.
Comment. ASG did a quick check of the NOx emissions and the maximum predicted concentrations are included in Table 2-1 below. With NO_2 concentrations expected to be about 1/10th of the NOx, it is agreed that the effects of NO_2 from the furnaces is less than minor.

Table 2-1. Modelled NOx from high temperature furnaces.

Maximum 1-hour NOx (µg/m³)								
2014	2014	2014	2015	2015	2015	2016	2016	2016
Max	99.9th	Max	Max	99.9th	Max	Max	99.9th	Max
1-hhr	1-hr	24-hr	1-hhr	1-hr	24-hr	1-hhr	1-hr	24-hr
20.7	9.1	3.7	29.9	9.1	3.5	20.1	9.5	3.9

Section 8.2.2 Dispersion modelling

The use of CALPUFF Version 7.2.1 is correct. The BOPRC\ASG meteorological data set for 2014-2016 was used. No buildings were included in the modelling as there are no structures to affect the Lawter plume. This is appropriate.

Mitigation.

Lawter current and proposed mitigation plans for PM is to;

1) continue to monitor the combustion conditions (CO and O_2) within the HT furnace to try and ensure complete combustion.
2) Install an inline monitor in early 2020.
3) Look to develop a pitch sales market thereby removing pitch as a fuel in the HT furnaces.

Point 2 was the preferred option over a baghouse or a centrifuge system which were deemed too expensive.

Monitoring

Lawter were required to conduct spot particulate monitoring every 6 months. The AEE recognises that this can be highly variable and have suggested Lawter consider an inline particulate monitor that provides live data and a reliable metric for particulate matter that can be used proactively by the operators. A feasibility study has shown that Later have identified the need to be able to accurately record their discharge of particulate matter and are looking to install a monitor in January. This has not been confirmed in this review.

Currently, there are nine monitoring sites for PM_{10} within the TMMA, all owned and managed by BOPRC and the Port. However, there are no $PM_{2.5}$ monitors. With the new MfE proposed $PM_{2.5}$ assessment criteria, combined with the relatively high particulate matter discharge from Lawter there is some merit in Lawter contributing toward $PM_{2.5}$ monitoring. Hewletts road is a recommended possibility due to a natural gap in the monitors at that location as well as its relative nearness to Lawter as well as the Port and its activities.

Therefore, it is recommended that Lawter conduct inline monitoring of both PM_{10} and $PM_{2.5}$ and off-site monitoring of $PM_{2.5}$.

2.1 Summary

The AEE recognised that there were multiple contaminants discharged to air from the HT furnaces including PM_{10} and $PM_{2.5}$, SOx, NOx, CO and VOCs, but only modelled PM. Although it was generally agreed that the other products of combustion were sufficiently low as to likely have negligible effects.

This review checked the AEE NOx emission rate and modelled NO_2 using the BOPRC\ASG models. ASG can confirm that the NOx emissions and the maximum predicted concentrations of NO_2 is minor.

The AEE used the correct version of CALPUFF for modelling purposes and used the ASG evaluated meteorological data sets which include fine scale terrain and land use effects. The AEE used the maximum consented PM emission rate of 3.2 kg /hr for modelling purposes which is appropriate.

There are some concerns that wind direction has been used as the sole determinator of Lawter contribution at the BOPRC monitors. This is simplistic and not true for light winds.

The PM_{10} and $PM_{2.5}$ modelling results of Lawter on its own predicted maximum 24-hour off-site ground level concentrations that were equal to 12% and 24% of the respective NES assessment. The annual concentrations were less than 10% of their respective AAQG criteria values. However, when background was added to Lawter contribution the results were significantly higher accounting for approximately 80% of the 24-hour assessment and 89% of the annual assessment.

A significant drawback of the modelling was that a proper cumulative assessment was not conducted. Modelling accounted for background, but not the explicit emissions from nearby industry. This is important as exceedances of the 24-hour PM standard occurred at the Marae monitor. It is anticipated that if the cumulative impacts were appropriately conducted the 24-hour and annual assessment criteria would be exceeded.

The current mitigations proposed by Lawter which include continual checks of the HT furnaces to ensure complete combustion and, the pursuance of a pitch market do not go far enough. An in-line $PM_{2.5}$ and PM_{10} flow meters are also recommended as well as off-site monitoring of $PM_{2.5}$ is recommended.

3. Review of Odours

3.1 Odour Overview

The assessment approach to odour and visible plumes by the AEE was based on a consideration of the 'Best Practicable Option' (BPO) for minimising odour and visible plumes. No dispersion modelling was conducted for odours.

There have been more than 22 odour complaints since December 2017, with 5 occurring in the 4 months to April 2020. Some of these complaints have been attributed to:

- Stoppages of the HT furnaces (including scheduled shutdown and unscheduled power failure of malfunction),
- cleanout of the CST storage tank,
- pressure test on the CST column, and
- a waste gas leak.

According to the AEE odour emissions from the Lawter site come from the storage tanks, process off-gas, the Rotoformer line, and other fugitive odours such as leaks and effluent management. For brevity these are briefly discussed below.

3.1.1 Storage Tanks

Most of the raw material processed on site as well as the final products are volatile organic compounds. The raw and processed material is stored in fixed roof storage tanks which consist of cylindrical steel shells with a permanently affixed roof. The main emissions from these tanks are the headspace vents which is associated with evaporative loss during storage (breathing loss) and filling and emptying operations (working loss). The breathing loss is due to changes in temperature or pressure, while the working loss is from changes in the liquid level. The tank headspace vents are considered to have the potential to cause significant sulphur type odour due to the nature of the raw CST and CTO stored on site. The CST is especially odorous due to a higher level of organic sulphur compounds.

3.1.2 Process off-gas

Waste gases from the process vessels (CTO distillation columns, CST distillation column, CPO distillation column and Resin reactors) have significant sulphurous type odour due to the raw CST and CTO on site.

3.1.3 Rotoformer line

Low level odorous vapours can occur from the Rotoformer line. These are low compared to the tank headspace vents and process off-gas due to the nature of the liquid form of downstream products used in the Rotoformer line.

3.1.4 Other fugitive odour emissions

Leaks - Potential fugitive odour is associated with the VOCs evaporated from sudden leaks of VOCs from process vessels and storage tank or pipelines. These leaks can occur when raw material is being unloaded or when the materials is removed for tank cleanout. Leaks can also occur from pumps, valves, connectors, compressors and pressure relief valves if not sealed properly.

Effluent Management - flush water and rain water from the process areas produces effluent streams that are collected in the sumps or bunding areas.

Shut down or failure of the HT furnaces – Shut down of the HT furnaces would cause the direct release of process off-gas and tank headspace vents.

3.2 Review and Comments

The AEE did not consider dispersion modelling as a practicable option for mitigating odours from Lawter. The AEE considered that the best way to prevent odour is to implement mitigation measures. It is understood that Lawter has recently reviewed its odour mitigation protocol after a number of odour complaints were received. It is understood that for odours the facility has the following existing mitigation measures in place;

3.2.1 Existing mitigation measures

- Under normal operating conditions, Lawter has a waste gas system to extract off gas from the main process vessels, CST and CTO. The extracted gas is incinerated by the HT furnaces along with the headspace vents extracted from storage tanks.

- Odour from the Rotoformer line are sent to the biofilter for odour treatment.

- During recent shut downs the Rotoformer bio filter system was connected to the waste gas extraction to treat tank headspace. (The AEE considered this not good practice since there was no active extraction).

- Many of the existing on-site storage tanks currently only have a single pressure gauge and extraction control rate. This means that any individual tank could be under high pressure (abnormal) instead of under negative pressure (normal), making it almost impossible to manage leaks and fugitive odour. Some of the odour complaints have been related to the storage tanks.

- CTO bulk tank that receives the raw CTO was not connected to the waste gas extraction system until recently.

- Up until recently there has been no leak detection or repair program to identify any leaking equipment until recently.

- If the furnaces are not available for short periods, i.e., when they are shut down or where waste gas is not being combusted, Lawter has been relying on the system capacity to maintain the tank vacuum. In other words, it has been assumed that the vacuum on the tanks is sufficiently high that during times of no extraction they remain high.

Given the current set of odour mitigation practices, it is not surprising that odour complaints have been received from Lawters. It is understood Lawter are proposing the following odour mitigation.

3.2.2 Proposed New Mitigation

- According to the AEE Lawter is currently upgrading all of their on-site storage tanks which is expected to be completed within 5-10 years. Each of the CST storage tanks will have an individual pressure gauge and extraction rate controls to ensure the tanks can be separately maintained under vacuum. This means that individual tanks can be much more easily monitored to see if they are operating at normal (negative pressure) or abnormal conditions (high pressure).

- It is understood that Lawter are investigating the installation of a permanent odour removing wet scrubber or a waste gas flare. These options would be installed prior to the biofilter and would be designed to remove or burn odour producing compounds from the waste gases. A temporary wet scrubber is being investigated as an interim measure for periods when the HT furnaces are not operating. The temporary scrubber would be retired if the waste gas flare is the preferred option.

- The AEE has recommended a Leak Detection and Repair program to identify any leaking equipment.

- The handling of odorous material from the CTO and CST are to be undertaken using safe handling practices to minimise material leaks. These management practices will include modifying the pumping flow rate and tank pressure and following emergency response procedures by staff if a leak occurs.

- According to the AEE a primary odour mitigation associated with the effluent streams is to transfer the waste streams from the sumps, bunding areas, outfall weir and effluent vessels to the wastewater tank for further treatment.

- Maintaining good combustion is necessary for Lawter to manage its odour. The HT furnaces are fitted with alarms that will alert plant operators of unfavourable combustion conditions.

3.3 Odour Summary

Lawter have had several odour complaints relating to plant shut down, non-incineration of waste gases, storage tank cleanout and removal and low waste gas pressure suggesting a leak in one of the CST storage tanks. From the above current existing mitigation, it seems that up till recently Lawter have been relying on incinerating their waste gases and relying on less than optimum tank storage vacuums. From the proposed mitigation measures it is clear that Lawter odour mitigation measures are a developing and that all the proposed measures need to be quickly put into place and rigorously enforced. In other words, upgrading all the onsite storage tanks with their own pressure gauges and extraction controls to ensure negative pressure is only one such measure. But this mitigation needs to be conducted in conjunction with managing the leaks and also having other active processes in place to manage the waste gases in case of a shut down.

The Lawter plant, like any plant is subject to disruption. However, when disruption occurs the waste gases are not going to be burnt. Currently, Lawter have no clear plan to actively extract, manage and treat the waste gases. The AEE refers to the installation of a wet scrubber to treat the waste when this happens, but Section 10.2.1 of the T&T AEE has ruled this out due to the high cost (~$1m, with up to $2m annual costs), as well as the significant waste stream produced by the scrubber which in their opinion negates the environmental benefits of reducing odour and SO_2. However, the AEE has suggested a small wet scrubber designed just for odour which could be potentially retrofitted to the existing system and be installed prior to the biofilter has not been ruled out. Similarly, a waste gas flare could also be designed to reduce odour impacts and also be retrofitted to the existing system prior to the biofilter to treat any waste gas that was not incinerated in the HT furnaces during unplanned shutdown or failure of the HT Plant. The AEE also see a bio gas flare as a viable alternative. Therefore, it is clear from the AEE no decisions have been made on any odour mitigation equipment at the time of writing this report.

ASG is in agreement with Golder that modelling of onsite odour would not be that helpful since most of the odours are fugitive and that the best way to prevent odour is to implement strict and robust mitigation measures. All of the above proposed mitigation measures will help in preventing off site odour, but the site still has the potential to cause significant off-site odour due to the nature of the raw material it receives and the final product it creates. A comprehensive odour management plan is recommended.

4. Review of Visible Plumes

4.1 Overview

The management of visual plumes arising from the HT furnaces forms one of the key conditions of Resource Consent 61693-AP which states the following;

Condition 5.1
The High Temperature furnaces and myrcene pyrolysis furnace shall be operated by the permit holder in a manner such that any smoke emission from the stack, after a 15 minute start up period, when smoke shall be kept to a minimum, shall not exceed 40% obscuration determined visually, for any continuous period of one minute in an hour or in total two minutes in an hour.

Visible white and black plumes are known to occur from the HT furnaces. These tend to occur during cold starts, shutdowns, soot blowing and incomplete combustion.

In the period from December 2017 to February 2019 a total of 5 complaints relating to visible plumes was made to BOPRC. Most of these related to a plume that resembled 'smoky fire' or 'black smoke'. An investigation into the most recent complaint found that a soot blow was carried out in the morning on that day. Records during previous dark plumes indicated low O_2 content and a high CO level within one of the HT furnaces.

Visible plume discharges were assessed in the AEE on a consideration of the Best Practicable Option (BPO), a qualitative approach that takes into consideration community complaints, management plan, onsite observations and a review of site control.

4.2 Visible Plumes - Function of Combustion

Visible plumes are largely a function of the combustion process which is the rapid oxidation of a fuel which requires high temperatures. Most common fuels contain carbon and hydrogen plus sulphur and ash materials. The ash does not burn, but the carbon, hydrogen and sulphur each combine with O_2 and produce heat and waste gases. Because these gases are mixed, for instance, O_2 is mixed with nitrogen in the air, in fuel, the hydrogen is compounded with the carbon to form complex tar and resins, and the sulphur is combined with other compounds or with elements like iron. In practice to ensure all the carbon and hydrogen combine with oxygen, three conditions must be maintained – often known as the 'three T's of combustion'. i.e.,

(a) sufficient time for the molecules of O_2 to come into contact with the molecules of fuel,
(b) an adequately high temperature to sustain the reaction,
(c) turbulence or mixing to make sure that all the molecules of fuel are combined with the O_2 in the air

If some of the fuel does not receive enough air or temperature to burn all the carbon, the ash will contain pieces of partially burned carbon, and when these particles remain in suspension in the flue gas, they form black smoke. If a furnace produces smoke, either the fuel and air are not in balance, or the three T's of combustion are not being satisfied.

White smoke from the HT furnaces is likely the result of finely divided particulates, usually liquid particles in the gas stream. These are caused by vaporization of hydrocarbons in the combustion chamber. White smoke is frequently attributed to excessive combustion air or loss of flame.

4.3 Lawter Mitigation Measures

In order to avoid visible plumes from occurring, it is understood that Lawter have O_2 and CO alarms. The O_2 is set at 2 – 6 % and the CO at > 300 ppm within the HT furnaces in order to ensure that the site operator is alerted to any abnormal combustion conditions.

In February 2019, Lawter installed a camera to continuously monitor the plume from the control room. In the event of a visible plume being present, the site process engineers are to check the stack conditions to determine the cause, which could be due to;

- Combustion conditions
- Fuel blend
- O_2 levels
- Wastewater quantity

The AEE have stated that the since the visual monitoring has been put in place no complaints have been lodged and therefore the continuous visual monitoring in conjunction with the O_2 and CO alarm levels means that no further mitigation is required.

4.4 Summary

4.4.1 Managing combustion processes

The best mitigation tool that Lawter employ for the control of incomplete combustion is the control of O_2 and CO within the furnace through alarms. The furnaces will produce smoke if the fuel and air are not in balance or the rules of combustion have not been satisfied, i.e.,

- insufficient air for the amount of fuel
- too much air, which chills the flame before combustion is complete
- insufficient turbulence of the air through the fuel
- cold furnace when the fire is first lit or is burning at a low load this is often accompanied by excessive air leaking from the furnace

Generally, the opaquer and darker the plume the more effluent is being emitted and the poorer the air quality. This is why the current regulation for restricting visible plumes in Condition 5.1 of consent 61693-AP shall not exceed;

40% obscuration determined visually, for any continuous period of one minute in an hour or in total two minutes in an hour

This ruling prevents plumes blacker than 40% obscuration from occurring. However, it is recommended that obscuration be reduced to 20% in line with other industrial practices in the region.

4.4.2 Managing fuel blends

The AEE have identified that fuel blends are a reason for visible plumes. CST is obtained from local pulp and paper industry which is high in sulphur compounds. Therefore, if fuel blend is a reason for visible plumes, Lawters needs to show how they can manage fuel blends to prevent visual plumes.

4.4.3 Manage Soot blowing events

Soot blowing is the process of removing soot that is deposited on the furnace tubes during combustion.   The AEE do not state how often soot blowing may occur, but these activities should be managed within the current consent conditions which allows a continuous plume for a period of one minute in an hour or in total two minutes in an hour.

Therefore, in summary although Lawter has some mitigation measures in place to manage visible plumes, it is expected that visible plumes are going to provide ongoing challenges for Lawter that will require careful progressive management.

5. Review of Sulphur Dioxide (SO_2)

5.1 Overview

Sulphur dioxide is the primary contaminant discharged from the two HT furnaces via a single stack of 40m height and 0.96 diameter. The HT plant has a SO_2 emission limit of 74 kg/hr under Resource Consent 61693-AP. Lawter has undertaken continuous emission monitoring to collect and record SO_2 emissions rates since 2014. The HT plant is equipped with a real-time monitoring system, which measures SO_2 discharge rates and concentrations, O_2 and CO levels in the exhaust and the exhaust flow rate.

The AEE did not conduct any SO_2 dispersion modelling preferring to rely on the BOPRCs 'SO_2 Air Quality Modelling Report prepared by ASG Ltd'.

This section, is split into the following sections:

Section 5.2 Continuous Emissions Monitoring
Section 5.3 Ambient Monitoring Data
Section 5.4 Findings and Interpretation by AEEs of BOPRC Model Results
Section 5.5 Modelling Results

Section 6 provides a discussion and summary of the findings of Section 5.

5.2 Continuous Emissions Monitoring (CEM)

5.2.1 Findings of the AEE

Section 5.2.1.1. Golder AEE. SO_2 emissions. The Golder AEE has provided a summary of the CEM data (excluding values that corresponded with negative flow rates) in Table 6 and Figure 23 of the AEE (both of which have been shown in Table 5-1 and Figure 5-1, for brevity). Table 5-1 shows eight exceedances of the consented limit during the period January 2018 to May 2019. A maximum SO_2 emission rate of 87 kg/hr (120% of the consent limit of74 kg/hr) occurred at 17:00 on 1 April 2018.

Table 5-1. Summary of the CEM SO_2 emission rates from Golder AEE.

Table 6: Summary of the CEM SO_2 emission rates recorded from January 2018 to May 2019 (excluding unreliable records).

Monitoring period	Maximum (kg/hr)	95th percentile (kg/hr)	Average (kg/hr)	Consent limit (kg/hr)	Number of exceedance (>74 kg/hr)
January 2018 to May 2019 (inclusive)	87	37	13	74	8

Figure 5-1. CEM SO_2 data for the period January 2018 to May 2019. All unreliable and negative data was not included. (Figure 23 of the Golder AEE).

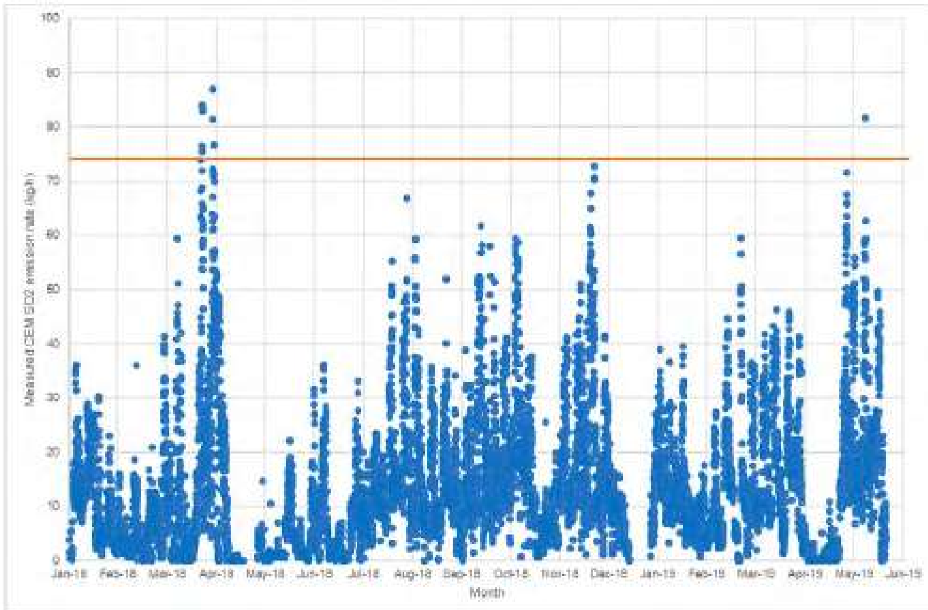


Figure 23: CEM SO_2 data recorded from January 2018 to May 2019 (excluding unreliable values).

5.2.2 Discussion on CEM monitoring Data

The AEE stated that the number of exceedances shown in the record (Figure 5-1) are mostly due to errors in the flow meter, and that the average measured emission rate was approximately 13 kg/hr consistent with ASG 2018 findings. For 95% of the time, the emissions rates were no greater than 37 kg/hr (also, consistent with ASG 2018 findings based on CEM results for 2014-2016).

An analysis of the 2014 – 2019 CEM data for data > 74 kg/hr is shown in Table 5-2. These potential exceedances include those determined by the AEE (Table 5-1). The key point in this table is that the 8 potential exceedances in the period January 2018 – May 2019 is double the number recorded in 2016.

Table 5-2. Valid Lawter SO_2 exceedances since 2014 to 2019.

Year	Date	No. of exceedances ➢ 74 kg/hr	Total
2014	12 May 00h-18h	8	
2014	4 September14h-22h	8	16
2015	2 June 01h 3 June 22h 5 June 11h-6 June 09h 11 June 14h-19h	1 1 9 5	16
2016	15 February 03h -07h 17 March 15h	3 1	4
2017	No data		
2018-2019	Not known	8	8
		44	

For clarity, the Lawter CEM data from 2014 to 2019, (excluding 2017) was cut and pasted into a single time series plot (Figure 5-2). The first period of data (2014-2016) is from the ASG 2018 report and the second period of data is from the Golder AEE, Figure 23.

Figure 5-2. Cut and paste time series chart of Lawter CEM data from 2014 - 2018 (Source ASG and Golder Figure 23).

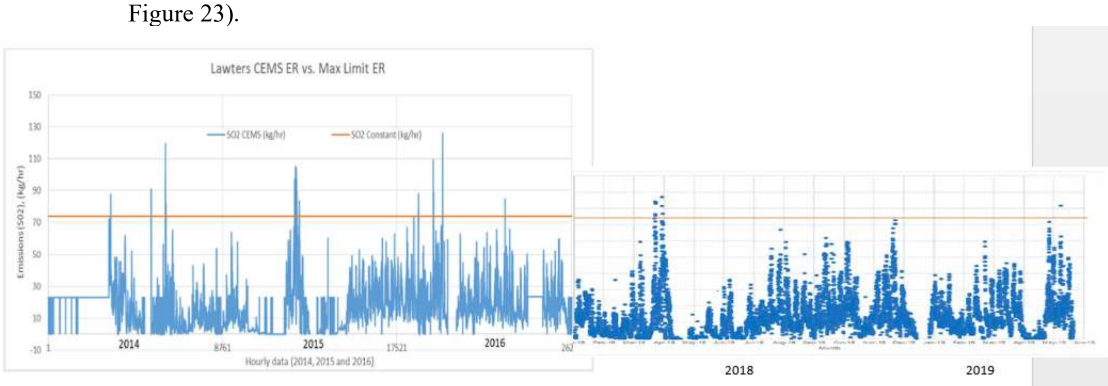


Figure 5-2 shows a remarkably similar trend of SO_2 emissions from 2014 right up until 2019. There are long periods were Lawter is emitting signficantly below the 74 kg/hr consent limit, such as late April to the middle of May in 2019. However, there are also quite long periods when Lawter is operating at close to its maximum consent limit.

In order to understand the current operations of SO_2 emission discharges, an analysis on all the CEM data since 2014 has been examined and discussed below. First, the invalid data was removed. Invalid data was considered all data that was attributed to shut downs, negative values, missing values, very small values, and any hours where any of the SO_2 computed concentrations were negative. Shown graphically the number of hours of valid and invalid SO_2 measured flow rate from 2014 to 2019 is shown in Figure 5-3. The plot is useful as it shows how the number of invalid hours of data have slowly decreased with each year, and how the number of valid hours of data have slowly increased with each year, such that in 2020 (January – March) there was no invalid data at all. Improvements to a (more than once) faulty flow meter is one reason why the valid data has gradually improved over time.

Figure 5-3. Valid and invalid hours of SO_2 kg/hr since 2014.

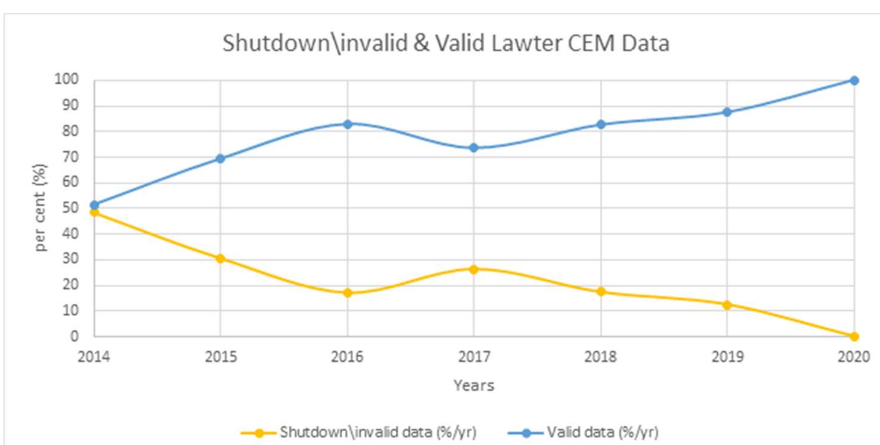


Table 5-3 shows a breakdown of measured SO_2 discharges in kg/hr for discrete bin sizes for each year from 2014 up to the end of March, 2020. Figure 5-4 is a graphical bar chart of the same data.

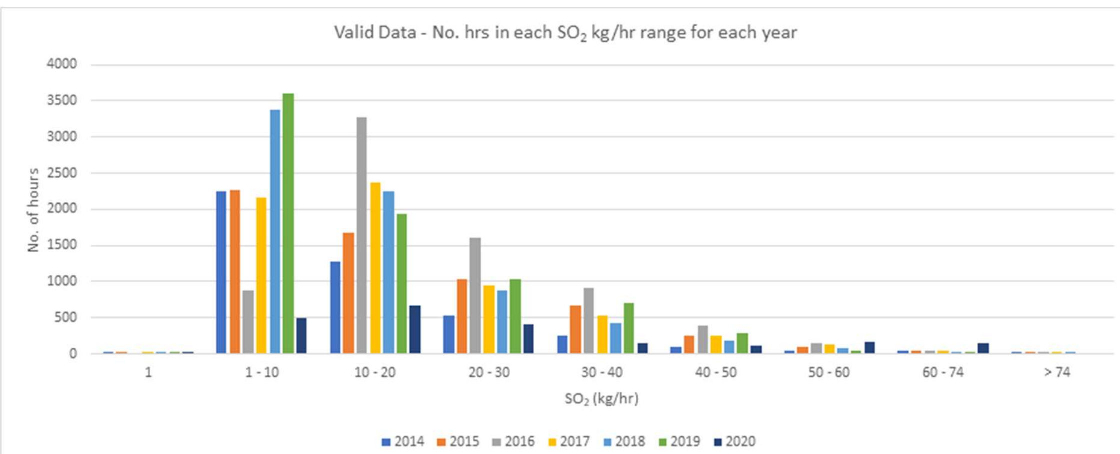
Table 5-3. Number of hours of SO_2 discharge in kg/hr as per discrete bins.

Number of hours emitting SO_2 in each category (Invalid data is not included)							
kg/hr SO_2	2014	2015	2016	2017	2018	2019	2020
1	7	2	0	1	2	28	3
2 - 10	2250	2263	869	2154	3380	3603	499
10 - 20	1281	1672	3269	2376	2252	1943	675
20 - 30	534	1038	1615	946	874	1038	400
30 - 40	259	676	915	532	423	696	146
40 - 50	88	260	397	256	184	293	116
50 - 60	46	91	149	135	83	47	168
60 - 74	48	81	49	43	40	19	144

Table 5-3 and Figure 5-4 show the following;

- By far the bulk of Lawter SO_2 emissions are < 20 kg/hr (46% - 75% of the time).
- 2020 has the highest number of emissions > 50 kg/hr even though it is only represented by three months.

Figure 5-4. Number of hours of SO_2 (kg/hr) in discrete bins.

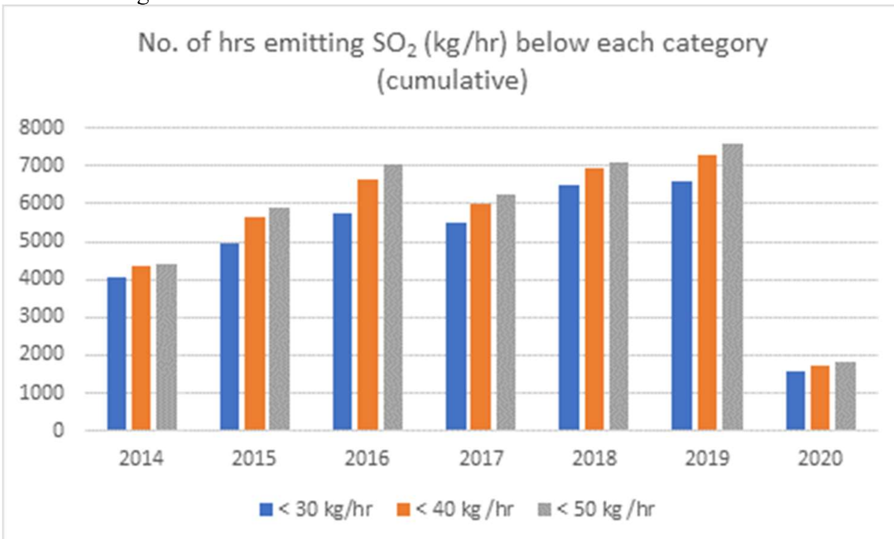


5.2.2.1 CEM SO_2 emissions < 50 kg/hr

Looking more closely at SO_2 discharges < 30 kg/hr, < 40 kg/hr and < 50 kg/hr, the hours for each category per year are detailed graphically in Figure 5-5 below. Note the values are cumulative, so anything in the < 50 kg/hr column includes anything less than 40 kg/hr and 30 kg/hr.

What is interesting here is that over the years there is a steady increase in SO_2 discharges up to 50 kg/hr. One of the reasons for this is the amount of valid CEM data that has steadily increased each year since 2014, i.e., there is more data to analyse.

Figure 5-5. Number of hours emitting SO_2 (kg/hr) for each year for three categories of < 30 kg/hr, < 40 kg/hr and < 50 kg/hr.



Both Golder and T&T have made percentage time emission limit recommendations. T&T have recommended a discharge limit of 50 kg/hr for 75% of the time, i.e., 6570 hours, and Golder have recommended a limit of somewhere between 40 – 50 kg/hr for 90 – 95% of the time, i.e., 7884 – 8322 hours.

Table 5-4 provides a table of current actual SO_2 discharges < 50 kg/hr, < 40 kg/hr and < 30 kg/hr in percent (representative of valid data in each year). Also included on each chart is the recommendation limits of T&T (75% of the time < 50 kg/hr) and Golder (90-95% of the time < 50 kg/hr.

The average actual SO_2 discharge < 50 kg/hr over the period 2014 – 2020 is approximately 75%. This value is consistent with T&T recommendations for a future Air consent, and is consistent with operations since 2014. Note that the T&T recommendation for future allowance of SO_2 use is essentially 'business as normal', it is not a suggestion to decrease SO_2 emissions. Golder recommendation allowing Lawter to emit below 40 - 50 kg/hr SO_2 for 90 - 95% of the time is unwarranted, especially when Lawter is currently operating for 79%, 83% and 80% of the time < 40 kg/hr for 2018, 2019 and 2020, respectively, and between 73% and 75% of the time < 30 kg/hr.

Table 5-4. Discharges of SO_2 for three categories as a percent of the time (Valid hours only per year). Golder and T&T recommendations have also been included.

	No. of hours emitting SO_2 (kg/hr) for each category									
Kg/hr SO_2	2014	2015	2016	2017	2018	2019	2020	Mean	T&T	Golder
< 30 kg/hr	46.5	56.8	65.7	62.5	74.3	75.5	73.3	65.0		
< 40 kg /hr	49.4	64.5	76.1	68.6	79.1	83.4	80.1	71.6		
< 50 kg/hr	50.4	67.5	80.7	71.5	81.2	86.8	85.5	74.8	75	95

The actual discharge of SO_2 per category since 2016 based on the average of each category in Table 5-4 are shown in Table 5-5. Golder allowance (90-95% of time) for SO_2 emissions < 50 kg/hr effectively allows much higher emissions than current operations in the upper ranges (> 40 kg/hr). The T&T allowance is effectively limiting emissions < 50 kg/hr and recommending substantially more emissions (25%) > 50 kg/hr, than current operations (163 hours or 1.86%).

Table 5-5. Average 2016-2020 actual discharges of SO_2, per category.

kg/hr SO_2 (actual % per category)	Actual (%)	T&T (%)	Golder (%)
< 30 kg/hr (70.0)	81.2	75	90 - 95
30 - 40 kg /hr (7.5)			
40 - 50 kg/hr (3.7)			

Therefore, based on these results which reflect actual operations, it is recommended that Lawter have a multi-tiered approach to their emission limits that takes into consideration the actual operations since 2016 in conjunction with dispersion modelling results.

5.2.2.2 CEM SO_2 emissions > 50 kg/hr - < 74 kg/hr

Both AEEs recommend Lawter retaining the upper limit of 74 kg/hr. T&T recommend SO_2 discharges be allowed > 50 kg/hr for 25% of time, or 2190 hours per year. Golder is recommending SO_2 discharges > 50 kg/hr for 5 - 10% of the time, i.e., 438 – 876 hours per year.

The numbers of hours of SO_2 discharges for discrete bin sizes > 40 kg/hr is shown in Table 5-6. The T&T and Golder recommendations are also shown as well as the average number of hours over all years. The total amount of discharge in the range 40 – 74kg/hr is summed as is the total amount of discharge in the range 50–74 kg/hr. Both these results are also presented in Table 5-6.

Table 5-6. Number of SO_2 discharge hours per year for different SO_2 emission bin sizes above 40 kg/hr. The average over all years as well as the recommendations by T&T and Golder are also shown.

	No. of SO_2 discharge hours for each category									
kg/hr	2014	2015	2016	2017	2018	2019	2020	Actual average	Golder	T&T
40 - 50	88	260	397	256	184	293	116	228		
50 - 60	46	91	149	135	83	47	168	103		
60 - 74	48	81	49	43	40	19	144	61		
Total 40 - 74	182	432	595	434	307	359	428	391	438 - 876	
Total 50 - 74	94	172	198	178	123	66	312	163 1.86%	438 – 876 5-10%	2190 25%

There are a few important points in Table 5-6. These are listed below;

- There are more hours in the 40-50 kg/hr category than the 50-60 kg/hr category and the 60-74 kg/hr category (as expected).

- The total number of actual hours > 50 kg/hr – 74 kg/hr has an average of 163 hours over all years (2014-2020). Years with above average hourly discharges are; 2015, 2016, 2017 and 2020.
- The year with the highest hourly discharge > 50 kg/hr is 2020 (312 hours), which is significantly higher than the next highest year, 2016 (198 hours). Possible reasons for this include;
  - No invalid data compared to other earlier years where there was lots of invalid data
  - SO_2 flow meter is working as expected (this was known to be faulty in previous years)
- The number of permitted hours > 50 kg/hr recommended by Golder and T&T is significantly higher than the actual operating hours > 50 kg/hr.

As noted in point three, the year with the highest number of hours discharging > 50 kg/hr and > 60 kg /hr is 2020 which is only represented by three months in Table 5-6, and not a full year. This suggests that the discharge of SO_2 > 50 kg/hr from Lawter is increasing (rather than decreasing).

Further the recommendations that Lawter continue to operate > 50 kg/hr by T&T (2190 hours or 25%) and 5 – 10% by Golder (438 -876 hours) is high when compared to operations since 2014 of 163 hours or 1.86% of the time. Consequently, it is recommended that the number of hours permitted in the upper range be determined on current and past operations as well as dispersion modelling, which is discussed in Section 5.5.

5.3 Ambient Monitoring Data

5.3.1 Findings of the AEE

The existing SO_2 air quality with respect to the ambient monitors is discussed in Section 3.3 of the Golder AEE. Table 5 is a summary of the monitoring data at the three owned BOPRC monitors, Marae, Bridge Marina and Totara street. According to the AEE, the monitoring results from the period 2016 – 2019 show the following:

- There is no exceedance of the NES SO_2 1-hour limits (either 570 µg/m^3 or 350 µg/m^3) or the 24-hour limit at the Totara and Bridge Marina sites.
- There are two exceedances found at the Marae monitor. The highest 1-hour SO_2 concentration of 750 µg/m^3 occurred on 5 March 2016. The second highest SO_2 concentration of 627 µg/m^3 was recorded at 10h00 on 27th February 2016. There is no exceedance of the AAQG 24-hour guideline at the Marae.
- 99.9 percent of the time the 1-hour SO_2 concentration monitored at the three sites were below the NES limit.
- There has been a substantial reduction of the 1-hour SO_2 concentration monitored at the Marae since 2017.

ASG is in agreement with these findings from the AEE, especially the last point. Table 5-7 provides a summary table of the SO_2 emissions from industry since 2014. The table shows that the 2018 SO_2 emission rates have dropped significantly from approximately 674.9 t/year in 2014, 551.3 t/year in

2015, and 526 t/year in 2016, to just 230 t/year in 2018. This shows a reduction in SO_2 emission rates by more than 50% since 2014.

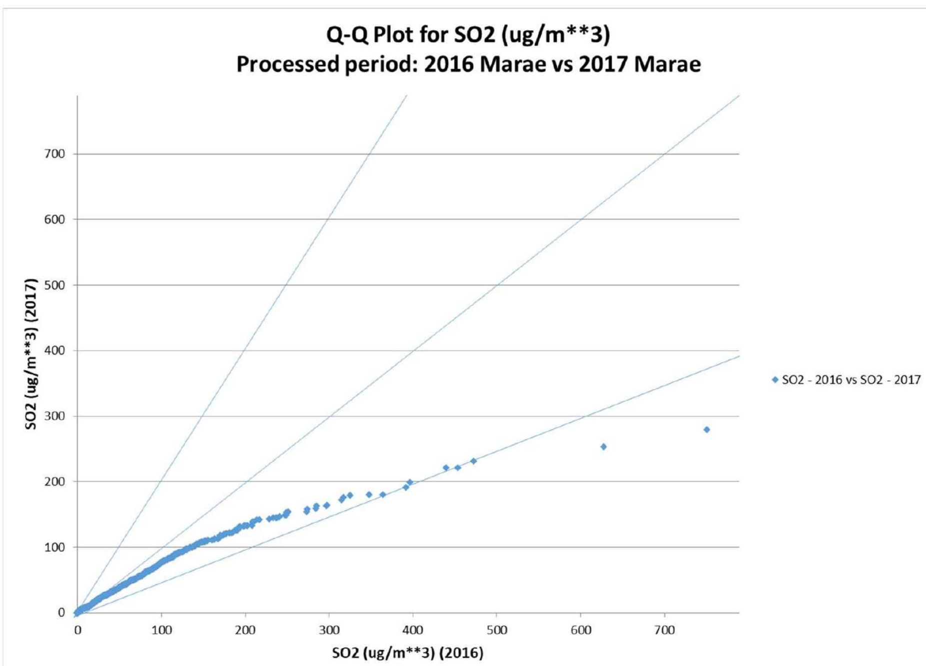
Table 5-7. SO_2 Emissions inventory for industry (fugitive emissions are not included and may be in the region of 3 – 9 t/yr).

Year	Industrial SO_2 Emissions (average) tonnes per annum	Uncertainty
2014	675.0	Significant variation (2014-2016) *2
2015	551.3	Significant variation
2016	526.6	Significant variation
2018	230.0	15%*1

*1 for continuous emission sampling (Environet, 2018)[9].
*2 continuous emission sampling for 2014, 2015 and 2016 showed significant variation of 38%, 57% and 54%, respectively (ASG 2018).

The Q-Q plot (Figure 5-6) shows the 2016 SO_2 concentrations paired against 2017 concentrations at the BOPRC Marae monitor. The plot shows that the 2017 SO_2 concentrations are significantly lower than those in 2016. These results highlight the significant reduction to SO_2 emissions by Ballance which undertook extensive operational changes with significant capital investment.

Figure 5-6. Q-Q Plot for 2016 SO_2 concentrations at the Marae are compared to 2017 SO_2 concentrations at the Marae.

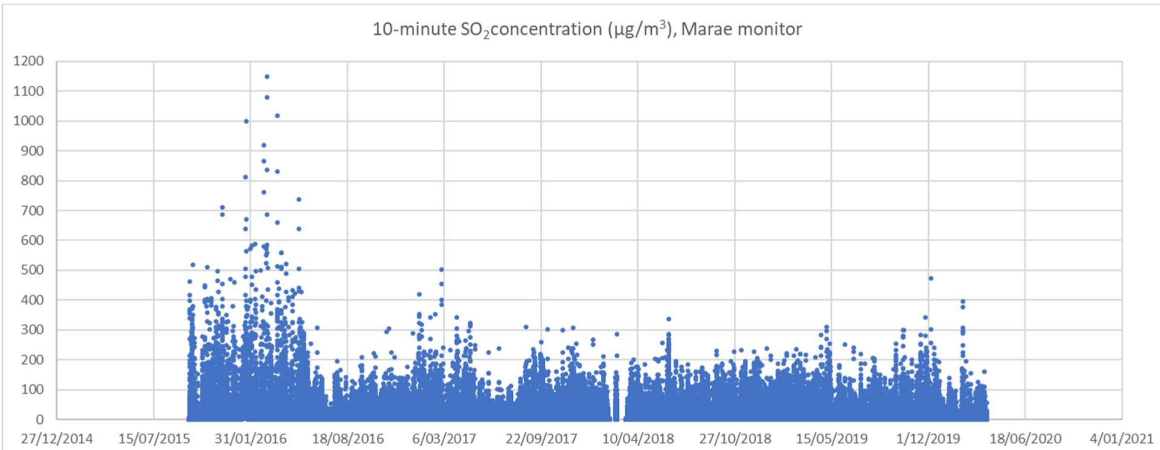


Further proof of the decrease in SO_2 concentrations since 2016 are shown in Figure 5-7 which represents 10-minute averaged concentrations from the Marae monitor. No exceedances of the WHO

[9] Tauranga Air Emission Inventory. Prepared for BOPRC. 2018. Environet Air Quality Specialists

10-minute assessment criteria of 500 µg/m^3 have occurred since 2016, nor any of the other NES assessment criteria. This reduction in SO_2 concentration is largely due to a reduction in emissions from the Ballance Acid Plant whose concentrations feature strongly at the Marae monitor due to the close location of the monitor to the plant and its well mixed plumes.

Figure 5-7. 10-minute SO_2 concentrations at the BOPRC Marae.



Section 3.3 of the Golder AEE have produced three wind direction vs monitored concentration plots (Figure 13, Figure 14 and Figure 15) for the Marae monitor, the Totara monitor, and the Bridge Marina monitor. These plots are similar to those conducted for $PM_{2.5}$ and PM_{10} (Figure 9 and 10) of the AEE. In each of these concentration vs wind direction plots the AEE has included lines demarcating narrow ranges of wind direction attributable to plumes from Lawter. For example, on Figure 14, Golder has attributed concentrations from Lawter for winds in the range of 165° - 195°, i.e., a 30° range. In Figure 13, (shown as Figure 5-8 below) for the Marae monitor, Golder has attributed concentrations at the monitor to be from Lawters in the range of 30° - 60°.

For any wind direction outside of this narrow band the AEE attributes those concentration to someone else and has effectively exonerated Lawter for all concentrations outside these narrow wind direction ranges. As discussed in Section 2 (for PM) this argument is persistently adhered to by the AEE. Golder does not provide any scientific reason to support this argument, other than Lawter is directly downwind of the monitor within those ranges.

Figure 5-8. Hourly SO_2 concentrations at Marae Monitor vs wind direction.

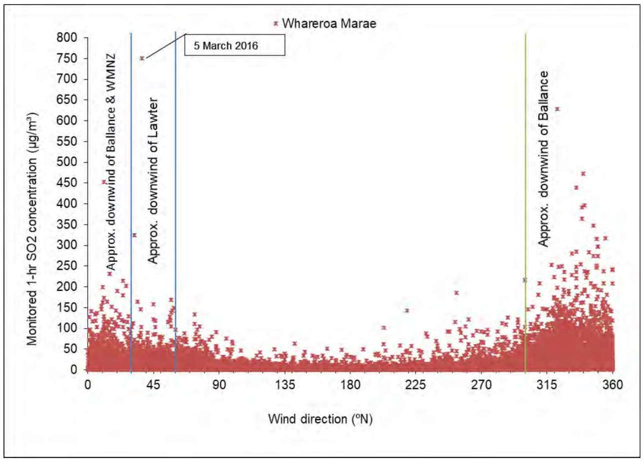


Figure 13: Monitored 1-hour averaged SO_2 concentrations (at the Whareroa Marae) versus wind direction, from January 2016 to April 2019. Downwind directions from Lawter (30 ºN to 60 ºN) are marked as two blue lines, along with downwind directions from the airport (60 ºN to 135 ºN), Ballance (300 ºN to 30 ºN) and WMNZ (0 ºN to 30 ºN).

As was pointed out in Section 2 the wind direction is constantly oscillating by 30° - 50°, significantly more so, when the winds are light. This means that the HT furnaces are likely contributing for any northerly or easterly moderate winds (3.3 – 5.4 m/s), and in light winds (< 3.3 m/s) the HT furnace contribution will most likely be from any wind direction.

Therefore, the contribution of SO_2 at the monitoring sites (Marae, Bridge Marina and Totara) under light wind conditions (< 3.3 m/s) which occur for 48% of the time are the combined contribution of all three industrial plumes plus other background, regardless of the wind direction.

Further, how much each individual facility contributes is also not straight forward as the AEE suggests. In an examination of the 41 WHO 10-minute exceedances which occurred at the Marae monitor in 2015 and 2016, four of these exceedances occurred in 2015 over three different days and 37 occurred in 2016 over fourteen different days.

For each 10-minute exceedance the same trends were noticed;

1) The wind direction was always from the northwest quarter and the wind speed in the range 1.5 m/s to 3 m/s.
2) Apart from 2 occurrences all exceedances occurred during the daytime between 09h-14h.
3) Most exceedances happened for at least 30 minutes, and
4) Almost all occurrences were in the summertime when the atmosphere is weakly unstable and unstable.

Although high Hydrogen Fluoride peaks[10] did coincide with several of the 10-minute SO_2 peaks at the Marae monitor, and it was acknowledged (in the ASG BOPRC report) that the output from Lawter was generally low during those peaks. It cannot be ruled out that Lawter was not contributing to those

[10] HF is a unique indicator of emissions from the superphosphate process. The design of the Acid plant SO2 emissions are directly related to sulphuric acid and fertiliser production rates as the acid is a raw material for fertiliser manufacture. Therefore, high HF measures at the marae suggest high SO2 emissions from the Ballance plant

peaks. This is important because the AEE have neglected to consider cumulative effects, preferring to just look at individual facility contributions rather than consider the combined effect of all industrial facilities plus the background effects. Further, in the US and other countries overseas, a facility contribution at a receptor or monitoring site is assessed using dispersion modelling. If the site is contributing more than 4% toward that exceedance then it is contributing to that exceedance.

In many of the peak SO_2 incidences the atmosphere leading up to the SO_2 peak events was characterized by light winds and highly variable wind directions. This effect is not easily or well modelled using 1-hour representative meteorology. ASG has shown how complicated and variable the monitoring and emissions is through the following points;

- There were 4 separate occasions when the Ballance Acid Plant emissions were below 50 kg/hr (i.e., well below their consent limits at the time) and yet SO_2 peaks still occurred at the Marae, and;
- Between 15 April and 13 May 2016, there were 130 hours when the Acid Plant was close to its limit, when the wind was from the northwest, and yet no SO_2 peaks occurred.

Therefore;

- The HT furnaces may well have contributed to the 2015 and 2016 SO_2 peaks and is continuing to contribute to periods of high SO_2.
- The HT furnaces are producing an intact buoyant plume that is subject to downwash, especially at onset of the sea breeze, anywhere between the hours of 09h00 and 12h00 and especially in summer.
- Highest concentrations from the HT furnaces can be expected under weakly unstable and unstable conditions anywhere within up to a 1km radius of the HT furnaces.
- The impact of the HT furnaces is not well represented at the Marae and Bridge Marina monitoring stations which are biased to Ballance whose plumes are mixed and much lower (due to structural effects on the Ballance premises) than those from the HT furnaces.
- The monitoring stations are just a snapshot of the plumes from the HT furnaces which have a much wider spatial footprint than those from Ballance. Because of the complexity in capturing the elevated Lawter plume, dispersion modelling is important.
- The HT furnaces cannot be considered in isolation and it is the cumulative impact of all three main industrial impacts plus the background that is important.

5.4 Findings and Interpretation by AEEs of BOPRC model results

In Section 9.2 of the Golder AEE, Golder stated that BOPRC concluded seven points and listed these in the AEE. ASG agrees with all of Golder's conclusions except for the second part of point 1, point 2, and point 7 (*in italics*). The two Golder conclusions (1 and 2, below) that ASG does not agree with are;

1) "The cumulative MEL assessment indicates that the maximum cumulative offsite 1-hour and 24-hour SO_2 glcs exceed their respective assessment criteria for each year. *This appears to be driven by the emissions from Ballance".*'

2) "*When considering Lawter MEL assessment by itself, the modelling found that the 1-hour and 24- hour assessment criteria would be just exceeded beyond the Lawter site boundary if SO_2 discharges at the consent limit of 74 kg/hr continuously*".

With respect to point #1, cumulative modelling. ASG wrote the following in the Executive summary of the MEL report;

a) The current consented maximum emission limits set for Ballance, WMNZ and Lawters result in cumulative and quite significant exceedances of both the 1-hour and 24-hour assessment criteria for all three years assessed.

With respect to point #2. ASG found the following;

b) The number and location of receptors that exceed the maximum cumulative 1-hour SO_2 assessment criteria of 570 μg/m^3 were shown in Figure 6-5 to 6-7 for both CEM modelling and MEL modelling for each year. The MEL modelling shows the Acid Plant and Lawter produce exceedances well beyond their plant boundaries.

Table 5-8 below shows the results of the ASG modelling as presented in the BOPRC reports. Assessed on its own at the consent limit of 74 kg/hr Lawter exceeded the 1-hour SO_2 maximum for all three years, the 24-hour SO_2 criteria and the computed 10-minute WHO SO_2 criteria. When assessed using CEM emissions data Lawter only showed exceedances of the computed WHO 10-minute assessment criteria. Figure 5-9 shows the location where the 1-hour (and 10-minute) maximum and 24-hour assessment criteria were exceeded. As can be seen from Figure 5-9, the 1-hour and 24-hour assessment criteria are exceeded 'well beyond' the Lawter site boundary when Lawters is emitting at its current consent limit of 74 kg/hr as per Golder's point # 2 above.

Table 5-8. MEL and CEM Lawter model results for 2014-2016 as per the ASG reports.

Industry Name	1-hour H1H 570 μg/m^3	1-hour H9H 350 μg/m^3	24-hour 120 μg/m^3	10-minute 500 μg/m^3 WHO	kg/hr
			Maximum emission limit (MEL)		
Lawters 2014	**707.8**	310.2	**126.2**	**1012.1**	74
Lawters 2015	**1023.5**	312.2	**121.5**	**1463.6**	74
Lawters 2016	**687.8**	326.0	**135.2**	**983.5**	74
			Continuous emission monitoring (CEM)		
Lawters 2014	425.8	153.3	53.7	**608**	13.8-21.4
Lawters 2015	522.4	130.7	63.6	**747.1**	13.8-21.4
Lawters 2016	351.7	142.9	66.2	**502.9**	13.8-21.4

Figure 5-9. Receptor locations where the 1-hour max (yellow), and 24-hour (magenta) SO_2 assessment criteria for Lawter were exceeded for three years 2014-2016 when assessed at the current consent limit of 74 kg/hr.

Further analysis of the number of receptors exceeding the 1-hour maximum assessment criteria is shown in Table 5-9. A total of 39 individual receptors either at the boundary or on the 20m or 80m receptor grid experienced an exceedance in either 2014, 2015 or 2016.

Table 5-9. Number of receptors exceeding the 1-hour maximum SO_2 assessment criteria for each year from Lawters operating at its consent limit of 74 kg/hr.

Industry Name	Fence line	20m receptor grid	80m receptor grid	Total
		1-hour Max Assessment Criteria 570 µg/m^3		
Lawters 2014	9	1	0	10
Lawters 2015	9	7	13	29
Lawters 2016	14	5	0	19
		24-hour Max Assessment Criteria 120 µg/m^3		
Lawters 2014	0	6	0	6
Lawters 2015	0	4	0	4
Lawters 2016	34	5	0	39

Based on the model results shown in Table 5-8, ASG (2018) suggested a discharge limit of 25% of the consented limits for all industrial sites. This value was not meant to be anything more than a suggestion, it was a number based on modelling to ensure that no exceedances of any of the SO_2 assessment criteria would occur beyond the site boundaries. It was always anticipated that each industrial site would consider appropriate maximum limits based on their capabilities and operations.

In point #7, The Golder AEE considered the proposed 25% reduction inappropriate for Lawter as they felt that it was driven by the cumulative 1-hour maximum exceedance in 2016 which was dominated by SO_2 discharged from Ballance.

However, Lawter have not provided any proof or scientific reason behind this statement, and they have not produced a similar plot to Figure 5-9 which shows the extent of the Lawter exceedances at 74 kg/hr as assessed on their own.

Both AEEs are supportive of the current maximum consent limit of 74 kg/hr, they believe that because SO_2 emission rates are continuously monitored if any SO_2 spikes are detected the site operator would stop or reduce the feed or adjust the fuel. The Golder AEE considers that these mitigation measures are appropriate to ensure SO_2 emission rates can be maintained within the consent limit.

However, the following points need to be taken into consideration:

1) Lawter has not reduced their discharge of SO_2 in seven years, if anything their emissions > 50 kg/hr are increasing, (supported by both the AEEs).

2) In the period 2018-2019 Lawter had 8, 1-hour maximum exceedances, this is double the number than 2016.

3) Lawter exceeded the 1-hour maximum NES, the 24-hour NES and the 10-minute WHO SO_2 assessment criteria for each year, when assessed on their own whilst emitting at their consent limit of 74 kg/hr.

4) Lawter has not considered the cumulative impact of SO_2 within the airshed. Assessed on their own they exceed the 1-hour and 24-hour NES. Cumulative analysis is a requirement of the Resource Management Act, which has not been addressed in the AEEs.

5) Although New Zealand has no National Environmental Standards on 10-minute averages of SO_2. The WHO 10-minute SO_2 standard is necessary within the TMMA to protect the health of communities living in close proximity to the industrial point sources. ASG found that the computed 10-minute concentration from the 1-hour concentrations was mostly lower than the actual modelled 10-minute data. This suggests that Lawter 10-minute glcs are likely higher than the computed 10-minute concentrations in Table 5-8.

6) Similarly, to Ballance and WMNZ, Lawter has fugitive SO_2 emissions that have not been modelled. ASG study pointed out that fugitive SO_2 emissions from all industry were likely to be a significant contributor, and it was a recommendation of that study that the industrial facilities use appropriate measures to estimate their fugitive SO_2.

Based on all the above, ASG recommends that Lawter re-consider how they can operate their business at a lower maximum emission limit for fewer hours than that suggested in the AEE.

It is important to remember, even though Lawter is not contributing significantly at the nearby monitors its plume is travelling intact much farther downwind than either the Ballance or WMNZ plumes due to substantial structural downwash at these facilities. The Lawter plume is therefore potentially more concentrate than any of the other industrial plumes. Further, these concentrate plumes can be ‘punched’ down to the ground anywhere within a few hundred metres up to a kilometre or so of the HT furnaces. Therefore, because the Lawter stack appears to be dispersing well when compared to the Ballance plumes, its effects due to unstable downwash are potentially as significant. The monitor sites, Bridge Marina and the Marae monitor are not very representative of Lawters plume, whose ‘punch down’ effects are much more random in nature. Figure 5-9 is a good modelling example showing such a far-field ‘punch down’ impact to the northwest of the HT furnaces caused by the onset of the sea breeze, combined with a rapid rotation of the winds in a weakly unstable atmosphere.

5.5 Modelling Results

Both Golder and T&T have made percentage limit recommendations. T&T have recommended a limit of 50 kg/hr for 75% of the time (6570 hours) and Golder have recommended a limit of 40-50 kg/hr for 90-95% of the time, i.e., (7884 – 8322 hours).

Both the Golder AEE and T&T AEE recommend retaining the upper limit of 74 kg/hr. T&T recommend SO_2 discharges be allowed 25% of time > 50 kg/hr or 2190 hours per year. Golder is recommending SO_2 discharges of 5 - 10% of the time above 50 kg/hr, i.e., 438 – 876 hours per year.

Dispersion modelling has been conducted (as part of this review) to consider the impact of the HT furnaces at 40 kg/hr, 50 kg/hr and 60 kg/hr (assessed alone). The results are presented in Table 5-10 and show that the 1-hour maximum, not to exceed SO_2 criteria of 570 $\mu g/m^3$ is exceeded at the plant boundary in 2015 at 50 kg/hr and 45 kg/hr. At 40 kg/hr Lawters did not exceed any assessment criteria beyond its plant boundary. Maps showing the location of the NES exceedances are presented in Appendix A.

Table 5-10. Dispersion modelling of various maximum emission limits for HT furnaces for 2014-2016.

	2014	2014	2014	2015	2015	2015	2016	2016	2016
SO_2 emission rate	1-hour Max (570 µg/m^3)	1-hour 99.9th (350 µg/m^3)	24-hour (120 µg/m^3)	1-hour Max (570 µg/m^3)	1-hour 99.9th (350 µg/m^3)	24-hour (120 µg/m^3)	1-hour Max (570 µg/m^3)	1-hour 99.9th (350 µg/m^3)	24-hour (120 µg/m^3)
40 kg/hr	382.6	167.8	68.2	553.2	168.8	65.7	371.7	176.2	73.1
45 kg/hr	430.4	188.6	76.7	**622.4**	189.9	73.9	418.2	198.0	82.0
50 kg/hr	478.3	209.6	85.3	**691.6**	210.9	82.1	464.6	220.2	91.6
60 kg/hr	**573.9**	251.5	102.4	**829.9**	253.2	98.5	557.6	264.3	109.6
74 kg/hr	**707.8**	310.2	**126.2**	**1023.5**	312.2	**121.5**	**687.7**	326.0	**135.2**

Table 5-11. Number of discrete receptors exceeding SO_2 criteria from Table 5-10 above.

	2014	2014	2014	2015	2015	2015	2016	2016	2016
SO_2 emission rate	1-hour H1H 570 µg/m^3	1-hour H9H 350 µg/m^3	24-hour 120 µg/m^3	1-hour H1H 570 µg/m^3	1-hour H9H 350 µg/m^3	24-hour 120 µg/m^3	1-hour H1H 570 µg/m^3	1-hour H9H 350 µg/m^3	24-hour 120 µg/m^3
40 kg/hr	-	-	-	-	-	-	-	-	-
45 kg/hr	-	-	-	4	-	-	-	-	-
50 kg/hr	-	-	-	6	-	-	-	-	-
60 kg/hr	2	-	-	13	-	-	-	-	-
74 kg/hr	10	-	6	29	-	4	19	-	39

6. Discussion and Conclusions

ASG has been engaged by Bay of Plenty Regional Council to conduct a review of a qualitative and dispersion modelling study of the emissions to air from Lawter NZ Limited. Golder Associates NZ Limited was engaged by Lawter to prepare a technical assessment of potential air quality effects on the environment associated with the operation of processing crude tall oil (CTO) and crude sulphate turpentine (CST) at 211 Totara Street, Mount Maunganui, Tauranga. The Golder report forms part of an Assessment of the Environmental Effects and an associated resource consent application by Lawter to continue its existing operation. A second Assessment of Environmental Effects which includes the Golder AEE was prepared by T&T in December 2019 and was prepared to accompany the Lawter application for a new air resource consent.

The key contaminants discharged from the HT furnaces stack are sulphur dioxide (SO_2) and, to a lesser extent, particulate matter, PM_{10} and $PM_{2.5}$ and nitrogen oxides (NO_2). The main pollutant of concern is SO_2. Odour and visible plumes are also key air quality concerns.

Currently the Lawter consent permits them to release up to 74 kg/hr SO_2. This consent expires on 30 June 2020. Both the AEEs are supportive of this current maximum limit, they believe that because SO_2 emission rates are continuously monitored if any SO_2 spikes are detected the site operator would stop or reduce the feed or adjust the fuel. The AEEs consider that these mitigation measures are appropriate to ensure SO_2 emission rates can be maintained within the consent limit. In addition to this, Golder has suggested an additional percentage limit of 5-10% of time that the emission can be up to 74 kg/hr and have suggested an emission limit of 40-50 kg/hr for 90 to 95% of the time. T&T have also suggested a percentage limit of 25% of the time that the emission rate can be > 50 kg/hr and up to 74 kg/hr with the remainder of the time (< 75%) at < 50 kg/hr.

Each of the key points identified in Sections 2 – 5 are discussed and summarised below.

<u>Combustion Gases (excluding SO_2)</u>

The AEEs recognised that there were multiple contaminants discharged to air from the HT furnaces including PM_{10} and $PM_{2.5}$, SOx, NOx, CO and VOCs, but only PM was modelled as it was generally agreed that the other products of combustion were sufficiently low as to likely have negligible effects.

The NOx emissions were modelled as part of this review and it was concluded that the predicted concentrations of NO_2 were minor. The Golder AEE used the correct version of CALPUFF for modelling purposes and used the ASG evaluated meteorological data sets which include fine scale terrain and land use effects. The AEE used the maximum consented PM emission rate of 3.2 kg /hr for modelling purposes which is appropriate.

There are some concerns that the AEE has incorrectly used wind direction as the sole determinator of the HT furnaces concentration contribution at the BOPRC monitors. This argument is not true for 48% of the time that light winds (< 3.3 m/s) occur, where the wind direction can oscillate significantly.

The biggest concern with the assessment of particulate matter is the analysis of cumulative impacts. The AEE has factored in a background value determined from the 95th percentile from the Marae and Totara monitors for the 24-hour PM_{10}. This value of 36 µg/m^3 was added to Lawter contribution. However as pointed out in this review, accounting for background is not the same as assessing the cumulative PM contribution within the TMMA. The AEEs have failed to take into consideration the cumulative impacts which should include;

Industrial emissions + Background + Lawter

where, industrial emissions include all nearby industry (Ballance and WMNZ); Background includes all other background such as Port, traffic, domestic heating, airport.

There is significant merit in modelling the combined industrial contribution as exceedances have been recorded at the Marae monitor, where the NES air standards were exceeded on three occasions. It is anticipated if cumulative modelling were considered correctly, the model results could be potentially causing exceedances of the NES assessment criteria.

Lawter current and proposed mitigation plans for PM is to;

- Continue to monitor the combustion conditions (CO and O_2) within the HT furnace to try and ensure complete combustion.
- Install an inline monitor.
- Look to develop a pitch sales market thereby removing pitch as a fuel in the HT furnaces.

Point 2 was the preferred option over a baghouse or a centrifuge system which were both deemed to be too expensive. In-line monitoring of PM is necessary and it is recommended that Lawter consider an off-site $PM_{2.5}$ monitor that will include both the contribution from Lawter as well as background. It is recommended that this new monitor be placed in the location of Hewlett road and approximately 400m distance from the HT furnaces. Lawter may have to consider either a baghouse or centrifuge system sometime in the future.

<u>Odour</u>

Lawter have had several odour complaints relating to; plant shut down such as non-incineration of waste gases, storage tank cleanout and removal, and low waste gas pressure, suggesting a leak in one of the CST storage tanks.

Lawter have proposed a list of mitigation measures. Most of Lawter odours are fugitive in nature and the proposed mitigation measures that include;

- upgrading all the onsite storage tanks,
- leak and detection software,
- managing the effluent waste streams,
- maintaining stringent odour management practices

are all expected to reduce fugitive odours to some extent. The nature of Lawter raw products and the final products it produces are also known to be potentially odorous, therefore sound mitigation practice also needs to be in place in the handling of these products.

The challenge for the plant is poor combustion of waste gases and the managing of the waste gases under frequent HT furnace shut downs. The AEE referred to the installation of a wet scrubber to treat the waste when this happens, but has been ruled out due to high costs and low environmental benefits for a possible much smaller ‘odour only’ wet scrubber or bio gas flare which can be retrofitted to the existing system and be installed prior to the biofilter. It is understood that at the time of writing this report Lawter has made no decisions on odour mitigation of the waste gases if the HT furnaces are not operating.

Visible plumes

Lawter has had complaints of visible plumes. The most likely reason for the HT furnaces to produce smoke is if the fuel and air are not in balance, or the rules of combustion have not been satisfied. Lawter currently control the combustion process through managing O_2 and CO within the furnace through alarm systems.

Visible plumes from Lawter are currently controlled by Condition 5.1 of consent 61693-AP which prevents 40% visual obscuration for any continuous period of one minute in an hour or in a total of two minutes in an hour. This ruling is important as it prevents opaque and dark plumes which usually means more pollutants are being emitted (as opposed to white plumes which usually reflect more water droplets). The current consent still allows for controlled removal of soot deposits from the furnace tubes. It is anticipated that these events will continue to occur, and are usually well managed.

Visible plumes are anticipated to be an on-going concern for Lawter**.** Therefore, although Lawter has some mitigation measures in place to manage visible plumes they are likely to be an ongoing occurrence and will require stringent management practices to remain within the consent conditions which control time and obscuration of the plumes. Plume obscuration of 20% is recommended as a new consent condition

SO_2 Continuous emissions monitoring (CEM)

An analysis of all the available Lawter CEM data was undertaken and the results have been presented and discussed in Section 5 of this report. The CEM data was analysed to try and determine (1) how the plant has been operating since 2014, and (2) to try and put into perspective the proposed new secondary and maximum consent limits recommended in the AEE of;

- Golder. 40 – 50 kg/hr for 90-95% of the time, and 50 – 74 kg/hr for 5 – 10% of the time
- T&T. 50 kg/hr for 75% of the time, and 50 – 74 kg/hr for 25% of the time

The following key points were found;

- eight exceedances of the current consented limit of 74 kg/hr occurred during the period January 2018 to May 2019. This is double the number that occurred in 2016.
- The CEM SO_2 trend from 2014 to 2020 is remarkably similar year after year.
- The number of invalid data (mostly negative values) showed a gradual decline year after year. Similarly, the number of valid hours of data gradually increased year after year, a likely reason for this may be improvements to the faulty flow meter.
- Most of the Lawter SO_2 discharges are < 20 kg/hr for 46% - 75% of the time.

- The highest number of SO_2 discharges > 50 kg/hr was in 2020 which is only represented by three months of data.

The average actual SO_2 discharge < 50 kg/hr over the period 2014 – 2020 is approximately 75%, and was 81.2% over the period 2016 – 2020, see the summary table (Table 6-1) below. The value of 75% is consistent with T&T recommendations for a future air consent limit as it is consistent with operations since 2014, but it does not suggest a decrease in SO_2 emissions. The Golder recommendation to allow Lawter a 'secondary' consent limit of 40 - 50 kg/hr SO_2 for 90 - 95% of time is unwarranted when Lawter is currently operating for 77.5% of the time at less than 40 kg/hr. Golder's proposed new secondary consent limit effectively allows Lawter to emit for 17.5% of the time in the range 40 – 50 kg/hr, when in reality they are only discharging in this category 3.7 % of the time.

Table 6-1. Average 4.5-year actual discharges of SO_2, per category.

kg/hr SO_2 (actual % per category)	Actual (%)	T&T (%)	Golder (%)
< 30 kg/hr (70)	81.2	75	90 - 95
30 - 40 kg /hr (7.5)			
40 - 50 kg/hr (3.7)			

Therefore, based on these results which reflect actual operations, it is recommended that Lawter consider a multi-tiered approach to their emission limits < 50 kg/hr that takes into consideration the actual operations since 2016 and dispersion modelling results.

Both the AEEs recommend Lawter retain the upper SO_2 discharge limit of 74 kg/hr. T&T recommend SO_2 discharges be allowed > 50 kg/hr but < 74 kg/hr for 25% of time, or 2190 hours per year, while Golder is recommending SO_2 discharges > 50 kg/hr but < 74 kg/hr for 5 - 10% of the time, i.e., 438 – 876 hours per year.

An evaluation of the CEM data for all valid hours > 50 kg/hr - 74 kg/hr showed the following;

- The average number of hours discharging > 50 kg/hr – 74 kg/hr from 2014 – 2020 is 163 hours.
- Years with above average hour discharges were 2015, 2016, 2017 and 2020, where 2020 was the highest at 312 hours, i.e., some 52% higher than the long-term average

Possible reasons for 2020 being such a high year, were thought to include, the increased number of valid hours in 2020, combined with the fact that the SO_2 flow meter was working as expected. But, since 2020 is only represented by three months in the analysis, and not a full year, the results suggest that the discharge of SO_2 > 50 kg/hr is increasing (rather than decreasing).

Table 6-2 shows the number of hours operating in the range 50 – 74 kg/hr vs that recommended by T&T and Golder. Both AEE recommended maximum discharge limits above 50 kg/hr are unwarranted when compared to actual operations since 2014.

Table 6-2. Average 2014-2020 discharges of SO_2, (number of hours) > 50 kg/hr – 74 kg/hr.

kg/hr SO_2 (no. of hours per category)	Actual (no. hours)	T&T (no. of hours)	Golder (no. of hours)
50 – 60 kg/hr (103)	163 [2020 - 312]	2190	438 - 876
60 – 74 kg /hr (60)			

Even though 2020 was a high year (312 hours > 50 kg/hr), the number of hours recommended by the AEE for Lawter to operate above 50 kg/hr appears unreasonable. Consequently, it is recommended that the number of hours permitted in the upper range (>50 kg/hr) be determined on current and past operations as well as dispersion modelling.

<u>Ambient monitoring of SO_2</u>

The monitoring data at the Marae monitoring station shows a significant reduction in concentrations since Ballance reduced the SO_2 emissions from the Acid Plant. The ten-minute Marae SO_2 concentrations show no exceedances of the 10-minute WHO of 500 $\mu g/m^3$ since 2016, nor any other NES criteria. However, it is also important to remember that the Marae monitor is biased to Ballance emissions due to the close location of the monitor to the plant, and its low well mixed plumes. On the other hand, Lawter with its intact plume does not have a very strong signal at any of the monitoring stations as the plume is mostly aloft. However, when the plume does come to ground which it can do on any day when the atmosphere is unstable, it's location could be anywhere within 1km of the stack.

The AEE has used narrow wind direction ranges to solely determine the HT furnaces contribution to SO_2 concentrations at each monitor. For any wind directions outside of these ranges the AEE has exonerated Lawter from contributing to any concentration. The AEE has used this argument extensively throughout the report with no scientific reasons to support their argument, other than the HT furnaces are directly downwind of the monitor within those ranges. Modelling is important for Lawter whose plume is more likely to downwash. Modelling is able to provide a spatial footprint rather than just provide a single snapshot at a single location.

<u>Modelling Results – Assessment of upper limit</u>

The AEE conducted no dispersion modelling for SO_2, preferring to rely on the BOPRC\ASG model results.
Therefore, modelling was conducted in this review to consider potential new maximum SO_2 emission limits. Modeling of SO_2 was conducted at 40kg/hr, 45 kg/hr, 50 kg/hr, 60 kg/hr and 74 kg/hr and the results were displayed as tables in Section 6 and in plots in the Appendix.

The dispersion model results showed the following;

- The 1-hour maxim (not to exceed) NES of 570 $\mu g/m^3$ was exceeded in 2015 for SO_2 discharges > 45 kg/hr, in 2014 for SO_2 discharges > 60 kg/hr, and in 2016 for a discharge of 74 kg/hr.
- The 24-hour maximum (not to exceed) NES of 120 $\mu g/m^3$ was exceeded in 2014, 2015 and 2016 for SO_2 discharges of 74 kg/hr
- Although the 10-minute (not to exceed) WHO criteria of 500 $\mu g/m^3$ was not shown in this report, exceedances would most likely have occurred.

- No assessment criteria beyond the plant boundary were exceeded for SO_2 discharges < 40 kg/hr.

The figures in the Appendix show the location of where each of the exceedances occurred. Most of these occur close to (within 80m) or at the Lawter plant boundary. But, SO_2 discharges > 58 kg/hr in 2015 show exceedances occurring in the harbour far beyond the plant boundary to the northwest. These are the result of down washing plumes in a weakly unstable and unstable atmosphere in the morning hours.

It is important to note that the AEE are not in support of the maximum 1-hour 'not to exceed' NES assessment criteria of 570 µg/m^3. The AEE considers assessing these criteria as conservative and suggests this should be assessed at the 99.9th percentile. This is incorrect. Further the AEE does not recognise the 10-minute WHO assessment criteria, which is also a 'not to exceed' value of 500 µg/m^3. However, the 10-minute standard like the 1-hour maximum standard are important due to the nearby communities to the industrial area.

<u>Model Accuracy</u>
The accuracy of the BOPRC SO_2 model accuracy is high and is well within a factor of two as can be seen in the quantile-quantile plots in Section 12 of the BOPRC\ASG CEM report. This is partly due to a robust three-dimensional meteorological data set. Therefore, the maximum 1-hour and 24-hour concentrations presented in this review are both reasonable, can be relied on, and are not overly conservative.

Taking this into consideration the modelling shows that the upper limit of 74 kg/hr is unlikely sustainable. Modelling has identified the potential for concentrated down washing plumes when Lawter emissions are > 58 kg/hr. As explained earlier, these down washing plumes can occur anywhere out to a distance of 1km around the HT furnaces.

<u>Cumulative assessment</u>
The AEE has not considered the combined cumulative impact of Lawter contribution in conjunction with that from Ballance and WMNZ or any other background emissions of SO_2. The AEE should have considered the following;

Nearby Industry SO_2 discharge (Balance, WMNZ) + Background (Shipping, port activities, airport, domestic heating, wood burning, white island) + Lawter

Assessing the cumulative contribution is important. Lawter on its own has exceedances, which means the combined contribution will produce potentially more exceedances. At its current operations Lawter on its own produces no exceedances, but the risk is when Lawter is emitting at its upper limits > 50 kg/hr at the same time that Ballance and WMNZ are too. It is acknowledged that these events are unlikely to coincide at the same time very often, but if and when they do the result could be significant.

The only way to assess the cumulative contribution of SO_2 or to assess the contribution of Lawter to an exceedance is through dispersion modelling. In the US the EPA has developed guidance on this matter[11] in the form of a screening tool, known as the Significant Impact Level (SIL) to help applicants and authorities determine whether a source's modelled ambient impact is significant so as to warrant conducting a comprehensive cumulative air quality analysis to demonstrate compliance with the National Ambient Air Quality standards. The EPA derived the interim 1-hour SIL by using an impact equal to 4% of the 1-hour SO_2 standard. If the source's modelled impact is found to be significant, at any receptor, based on the SIL, the applicant is required to complete a comprehensive, cumulative air quality impact analysis to demonstrate that the source's emissions will not cause or contribute to a modelled violation of any National standard. A cumulative analysis within a modelling area must include the modelled impacts of other sources (existing and permitted), including applicable SO_2 sources located outside the immediate area.

If this reasoning had to apply in New Zealand, 4% of the 1-hour NES would be 22.8 $\mu g/m^3$ and 14 $\mu g/m^3$ of the 1-hour 99.9th percentile NES. For both the 1-hour standards the Lawter impact would be greater than the SIL and therefore would warrant a cumulative assessment. The cumulative assessment must demonstrate that Lawter emissions will not cause or contribute to a modelled violation of any standard. Accordingly, Lawter would then need to evaluate its contribution to any modelled violation of the 1-hour standard to determine whether its emission contributions caused or contributed to the modelled violation at any receptor.

Mitigation

The AEE consider the 40m high stack of the HT furnaces a positive mitigation. It is true that by virtue of having a tall buoyant source and no structures to force the plume to mix to the ground that the HT furnaces are a positive mitigation as dispersion is mostly good. But the plume is also a major emitter of SO_2 into the TMMA which is being dispersed across mostly residential and industrial land uses, plus it has the capacity to quickly come to ground as a concentrated plume under the right meteorological conditions.

Currently Lawter maintain the monitoring equipment and SO_2 alarms and have recently upgraded the flow meter to ensure accurate SO_2 monitoring. For the future proposed mitigation. The T&T AEE is recommending a secondary not to exceed 50 kg/hr for more than 25% of the time. ASG agrees that the SO_2 alarms and the good working order of the flow meter are very important as is the prompt response of the management, but the proposed mitigation does not go far enough, especially given the following;

- The Golder AEE recommend just 5-10% > 50 kg/hr, and
- The average actual operations are only 1.8% (163 hours) > 50 kg/hr
- There are exceedances at the plant boundary when assessed alone at 45 kg/hr
- There are exceedances beyond the plant boundary when assessed alone at 58 kg/hr

The T&T AEE considered alternate mitigation strategies relating to SO_2. Four options were considered; a wet scrubber, a recycling of Pass 1, low sulphur CST and the purchase of non-local CST. Unfortunately, all four of these were ruled out including the wet scrubber which was deemed too expensive with some concerns at the waste stream that would be generated.

[11] US EPA Memorandum. August 2010. Guidance concerning the Implementation of the 1-hour SO2 NAAQS for the Prevention of Significant Deterioration Program.

SO$_2$ Considerations

From an air quality perspective, the most significant issue for Lawter is its operations at > 50 kg /hr of SO$_2$ discharge. The AEE recommendations to allow Lawter to emit above these levels for 10% and 25% of the time is unwarranted and beyond the plant current operations. Further the BOPRC CEM modelling conducted by ASG in 2018 was conducted on much lower actual operating emissions.

Dispersion modelling which is a more reliable indicator of ground level concentrations than monitoring has shown that significant exceedances occur well beyond the plant boundary at both 74 kg/hr and >58 kg/hr, and therefore does not support a maximum upper limit > 58 kg/hr. However, it is hard to know how Lawter can meet a new lower upper limit without considerable capital expenditure. No indication on how they might do this has been provided.

The following discharge limits are tentatively recommended based primarily on actual operations and dispersion modelling. They are the recommended minimum requirements for Lawter as they only consider the effects of Lawter when assessed alone and do not take into account cumulative effects.

Lawter will need to find an acceptable balance that takes into consideration; modelling, current operations, cost, environmental benefits, cumulative effects and feasibility.

Table 6-3. Recommendations for potential SO_2 consent limits. Note. These are the minimum recommended limits, cumulative impacts have not been taken into account.

kg/hr SO_2	Recommendation	Determination	Exceedances (assessed individually)	Reason for recommendation
74	Not recommended	Based on dispersion modelling	Significant exceedances at and beyond plant boundary of; 10-minute, 1-hour max and 24-hour	Lawter currently experiencing up to 8 exceedances in 2018
60	Not recommended	Based on dispersion modelling	1-hour maximum up to 800m from stack	Significant exceedances beyond the plant boundary
58	Recommended new consent upper limit	Based on dispersion modelling	1-hour max at the plant boundary	Current operations since 2014 show Lawter operating on average 60 hours > 60 kg/hr. However, 2020 was 144 hours. Therefore, some significant reduction will be required to meet this limit
50 – 58	87 hours or 1% of the time	Based on dispersion modelling and average of actual operations since 2014	1-hour max at the plant boundary	Current operations since 2014 show Lawter operating on average 100 hours > 50 kg/hr. However, 2020 was 168 hours, but 2019 was 47 hours. Therefore, Lawter should be able to meet this limit
40 - 50	262 hours or 3% of the time	Based on dispersion modelling and average of actual operations since 2014	1-hour maximum at the plant boundary > 45 kg/hr	Current operations since 2014 show Lawter operating on average 228 hours > 40 kg/hr, or 2.6% of the time. Lawter should meet this limit comfortably
< 40 kg/hr	96% of the time	Based on dispersion modelling and average of actual operations since 2014	No exceedances	Current operations since 2014 show Lawter operating at less than 20 kg/hr for between 46% and 75% of the time. 2019 was one of the lowest emitting years and Lawter was meeting this criterion for 83.4 % of the time, therefore it should be able to meet this limit comfortably

7. Appendix A – Maps Showing Location of NES exceedances

Table 7-1. Location of 1-hour maximum exceedance (> 570 µg/m^3) of SO_2 at 45 kg/hr, 2015.

Table 7-2. Location of 1-hour maximum exceedance (> 570 µg/m^3) of SO_2 at 50 kg/hr, 2015.

Table 7-3. Location of 1-hour maximum exceedance (> 570 µg/m³) of SO_2 at 60 kg/hr, 2014.

Table 7-4. Location of 1-hour maximum exceedance (> 570 µg/m³) of SO_2 at 60 kg/hr, 2015.

Table 7-5. Location of 1-hour maximum exceedance (> 570 µg/m³) of SO_2 at 74 kg/hr, 2014.

Table 7-6. Location of 24-hour maximum (> 120 µg/m³) of SO_2 at 74 kg/hr, 2014.

Table 7-7. Location of 1-hour maximum exceedance (> 570 µg/m^3) of SO_2 at 74 kg/hr, 2015.

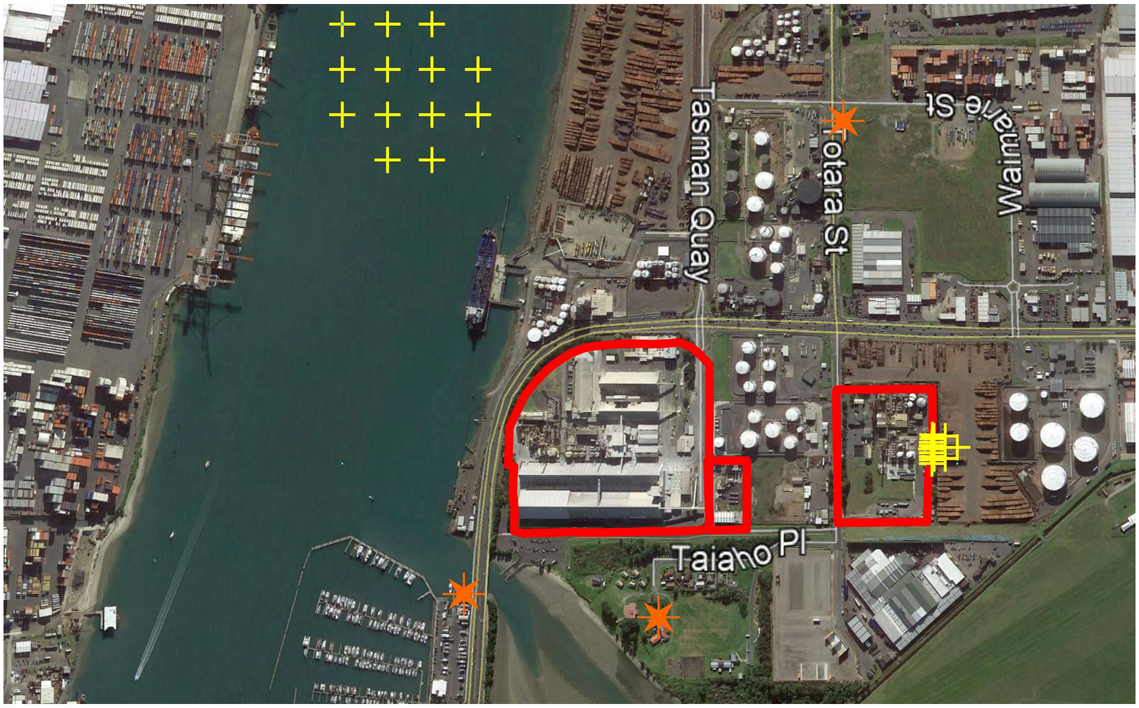


Table 7-8. Location of 24-hour maximum exceedance (> 120 µg/m^3) of SO_2 at 74 kg/hr, 2015.

Table 7-9. Location of 1-hour maximum exceedance (> 570 µg/m^3) of SO_2 at 74 kg/hr, 2016.

Table 7-10. Location of 24-hour maximum exceedance (> 120 µg/m^3) of SO_2 at 74 kg/hr, 2016.

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