Cumulative Impacts of SO_2 in the Tauranga, Mount Maunganui Area (TMMA).

Attention:

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August, 2020

Executive Summary

ASG has been engaged by Bay of Plenty Regional Council to conduct a cumulative assessment of SO_2 within the TMMA. This work follows on from three recent Environmental Air Assessments that were conducted in 2019 on behalf of Ballance Agri Nutrients (Ballance) and Lawter NZ Limited (Lawter).

In July 2019 AECOM developed an Air Quality Impact Assessment (AQIA) on behalf of Ballance which took into account SO_2 dispersion modelling of current (2017 – 2018) operations after Ballance had undergone significant capital expenditure on new SO_2 technology. The modelling took into consideration the new Ballance proposed maximum emission limit of 40 kg/hr for the Acid Plant.

In August 2019 Golder produced a 'Technical Air Quality Assessment Report' on behalf of Lawter which included dispersion modelling of particulate matter and an analysis of SO_2. Lawter is currently applying for a new Resource Consent RM19-0753, as their existing consent expired in June 2020. The Golder Air Assessment was followed up with a another more detailed Assessment of Environmental Effects (AEE) from Tonkin & Taylor in December 2019.

An important limitation of the AEEs is that none of them considered the modelled cumulative assessment of SO_2 within the Tauranga Mount Maunganui Area (TMMA). Conducting a cumulative assessment is a requirement of The Resource Management Act (RMA 1991)[1], which requires an 'assessment of the overall end result – the cumulative effect'. The Lawter AEEs preferred to reference the BOPRC\ASG SO_2 dispersion models, while the Ballance AQIA did not consider any cumulative contribution at all.

Assessing the cumulative SO_2 contribution is important. Not only is the air shed 'full', but assessed individually at their current and proposed maximum emission limits, Ballance and Lawter experience exceedances of the NES 1-hour and 24-hour SO_2 criteria. This means when the combined contribution is taken into consideration in combination with the background from other sources such as White Island, domestic heating, shipping and port activities, the cumulative ground level concentrations could potentially be significantly higher. Health risks may be potentially significant if the three major industrial sources were emitting close to their current and proposed limits simultaneously. Therefore, a cumulative impact assessment within the TMMA for SO_2 is necessary.

In this report the cumulative SO_2 effects have taken into consideration the sum of Background SO_2, which excludes industry, but includes SO_2 emissions from domestic heating, shipping, port activities, White Island and traffic, plus the specific modelled contributions from Ballance, Waste Management New Zealand (WMNZ) and Lawter. An hourly 98^{th} percentile (24 µg/m^3) and 24-hour (16 µg/m^3) average Background SO_2 values were taken from BOPRC Rata Monitoring station that is the furtherst of the BOPRC monitors from the industrial precinct, which has a clear signal from the Port and virtually no industrial signal at all. The background values were determined from 10-minute monitoring data from January 2020 until May 2020 and represents the lower sulphur fuel content

[1] Ministry for the Environment. Good Practice Guide for Atmospheric Dispersion Modelling.

(0.5%) of ingoing and outgoing ocean-going vessels consistent with New Zealand's commitment to MARPOL since January 2020.

Dispersion modelling was used to assess the cumulative contribution of SO_2 for 4 individual scenarios, where Scenario 1 represents the proposed emission limits of Ballance (Acid Plant 40 kg/hr, Manufacture stack 10 kg/hr), and the emission limit at which Lawter produce no exceedances beyond their pant boundary (58 kg/hr). Scenario 2 and 3 assessed the cumulative impact where gradual reductions in Lawter upper limit was assessed. Scenario 4 assessed the cumulative impact where all industry was assessed at reduced levels of SO_2, (Acid Plant 30kg/hr, Manufacture Plant 5 kg/hr, WMNZ 0.8 kg/hr, Lawter 40 kg/hr).

The cumulative results are shown as plots which show the locations of the NES 1-hour and 24-hour exceedances for all three years combined. Exceedances of the 1-hour maximum NES occur beyond the plant boundary for Scenario 1, Scenario 2 and Scenario 3. These exceedances primarily occur to the west of the Ballance Plant and are the combined effect of both Lawter and the Acid Plant. At the 99.9th percentile limit there are some exceedances within approximately 80m of the west of the Ballance plant boundary for Scenario 1, 2 and 3. Exceedances of the 24-hour criteria occur for Scenario 1, 2 and 3, and extend approximately 80m to the west of the Ballance plant boundary. These are also congregated around the WMNZ border, especially the border between Ballance and WMNZ. There were no exceedances for Scenario 4 beyond the plant boundaries for any of the NES.

If all three facilities were emitting simultaneously at these maximum emission limits then exceedances can be expected to occur beyond the industry plant boundary for maximum emission limits set at Scenario 1, 2 and 3. However, the chance of these industries all emitting together simultaneously at their upper limits is low. Secondary limitations will ensure that the number of hours emitting close to the upper limits is kept to a minimum.

The modelling in this assessment used the BOPRC\ASG models for 2014-2016. This data set has been fully evaluated and employs state-of-science models and modelling techniques. It is expected that the dispersion model accuracy is well within a factor of 2, and that the maximum 1-hour, 99.9th 1-hour and 24-hour concentrations are both reasonable, can be relied on, and that they are not overly conservative.

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1. Introduction

1.1 Overview

ASG has been engaged by Bay of Plenty Regional Council (BOPRC) to conduct a cumulative assessment of SO_2 within the TMMA. This work follows on from a recent Air Quality Impact Assessment (AQIA) that was conducted in 2019 on behalf of Ballance Agri Nutrients (Ballance) and two Assessment of Environmental Effects (AEEs) on behalf of Lawter NZ Limited (Lawter). The first air assessment was conducted in July 2019 by AECOM on behalf of Ballance. This AQIA conducted SO_2 dispersion modelling of current operations of the newly overhauled SO_2 equipment at the Ballance facility, as well as the new proposed maximum emission limits of 40 kg/hr for the Acid Plant. In August 2019 Golder produced a 'Technical Air Quality Assessment' which included dispersion modelling of particulate matter, and discussions on SO_2 on behalf of Lawter NZ Limited (Lawter) who is applying for a new Resource Consent RM19-0753 as their existing consent expired in June 2020. This Air Assessment was followed up with a another more detailed AEE from Tonkin & Taylor in December 2019.

The AQIA and AEEs referenced in this report are;

1) Technical Air Quality Assessment, Lawter NZ Limited. August 2019. Submitted by Golder Associates Limited.
2) Air Discharge and Re-Consenting. Assessment of Environment Effects. December 2019. Submitted by Tonkin and Taylor Ltd.
3) Atmospheric Dispersion Modelling Assessment. Mount Maunganui Fertiliser Plant. July 2019. Submitted by AECOM.

ASG has reviewed these AQIA and AEE reports and the findings are documented in;

- ASG Review of Golder and T&T Air Quality Impact Assessment for Lawter NZ on behalf of BOPRC.pdf
- ASG Review of AECOM Air Quality Impact Assessment for Ballance Agri Nutrients on behalf of BOPRC.pdf

1.2 Importance of Cumulative Impacts

An important limitation of the AEEs and AQIA is that no modelled cumulative assessment of SO_2 was conducted, even though a cumulative assessment is a requirement of The Resource Management Act (RMA 1991). The RMA requires an assessment of the overall end result – the cumulative effect. This means that the modelled concentrations must be added to the background concentrations. The following definition from Auckland Council 2014 applies:

Background air quality means ambient levels of air contaminants not associated with the sources that are explicitly included in the resource consent application. This includes the contribution from any other anthropogenic sources such as industry, domestic heating and transport.

The Good Practice Guide for Dispersion Modelling (GPG) makes the point that in most cases, an assessment of cumulative effects is required, and in some cases, it is viable to explicitly model the likely cumulative ground level concentrations caused by other sources in the area. However, the GPG is not specifically clear explaining when one should specifically model other sources, or when one can just use a background concentration. The GPG appears to make this distinction that one must model the sources when there is no available background data. This is misleading terminology and is not consistent with other International or US EPA practice. As an example, for assessing cumulative PM, Golder summed a background concentration of 36 µg/m^3 which was determined from the 95th (438th highest concentration) percentile from the Whareroa Marae monitor to Lawter contribution of PM. Potential issues with this method is the following;

1) Where did Golder get the 95th percentile value to represent background from? This is the 438th highest concentration at the Marae monitor. Why didn't Golder use the 99.9th (9th highest concentration) or, the 98th percentile value (218th highest)?
2) The Whareroa Marae has a strong signal from industry (Ballance, Lawter and WMNZ) due to its nearby location. By using the Marae monitor Golder has;
    a. represented industry, but is just a snap shot of the spatial industrial footprint
    b. double counted Lawter contribution (some of Lawter contribution is already captured in the Marae monitor).

A more accurate and realistic way of assessing cumulative PM would have been to explicitly model nearby industry PM emission and then sum the cumulative industry concentrations at each receptor to the Background PM which could have been derived from a monitor at say the 98th percentile level that does not include the industry signal, but is still representative of the TMMA. This approach is more in line with International practice, in particular the US EPA which has been explained below;

1.2.1 US EPA Approach to Cumulative Analysis

The only way to properly assess the cumulative contribution is through dispersion modelling. In the US the EPA has developed guidance on this matter[2] 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 in order to demonstrate compliance with the National Ambient Air Quality standards. The US 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 was found to be significant (i.e. > 4%), at any (modelled) receptor, based on the SIL, the applicant is required to complete a comprehensive, modelled 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) as well as background (all other SO_2 sources in the air shed such as domestic burning etc).

By applying this screening tool to the TMMA, 4% of the 1-hour maximum and 1-hour 99.9th percentile NES would be 22.8 µg/m^3 and 14 µg/m^3. The contributions of Ballance and Lawter as assessed by modelling are both greater than this 'approximated' 'NZ SIL' which suggests that both facilities are 'contributors' and therefore a detailed modelled cumulative assessment analysis is

[2] US EPA Memorandum. August 2010. Guidance concerning the Implementation of the 1-hour SO_2 NAAQS for the Prevention of Significant Deterioration Program.

warranted. Any exceedances of the NES at any receptor is considered a 'modelled violation'. It would be up to each individual facility to then evaluate its own contribution to that model violation to see whether its emissions either caused or contributed to that model violation.

1.2.2 Cumulative Approach Used in this Assessment

Assessing the cumulative SO_2 contribution is a requirement of the RMA. Not only is the air shed 'full', but assessed individually at their proposed maximum emission limits (Ballance Acid Plant 40 kg/hr, Lawter 74 kg/hr), Ballance and Lawter experience exceedances of the NES 1-hour and 24-hour SO_2 criteria. This means that when the combined contribution is taken into consideration in combination with the background from other sources such as White Island, domestic heating, shipping and port activities, the cumulative ground level SO_2 concentrations will be higher again.

There may be potential health risks if Ballance, WMNZ and Lawter were emitting close to their maximum consent limits, concurrently. It is for this reason that cumulative SO_2 impacts are a requirement of the RMA.

In this report a cumulative SO_2 impact assessment has been conducted which takes into consideration the following:

Background + Industry

Where,

- Background is the contribution of SO_2 from all other sources excluding industry. All other sources include (domestic heating, ship and port activities, White Island and traffic activities).

- Industry is the specific modelled output from each contributing industrial activity (Ballance, WMNZ and Lawter)

Section 1.3 discusses how the Background SO_2 value was determined.

1.3 Background SO_2

Background SO_2 was estimated from an analysis of BOPRC monitors in the vicinity of the TMMA. Figure 1-1 shows the location and details of each of these BOPRC monitors. Five of the monitors record SO_2;

- Rata Street (approximately 2km north of industrial sites),
- Totara street (approximately 500m north of the industrial sites),
- Whareroa Marae (approximately 200m south of the industrial sites)
- Bridge Marina (approximately 200m southwest of the industrial sites)
- Sulphur Point (approximately 1.2km or so west north west of the industrial sites), and
- Rail Yard south (approximately 1.5 km north of the industrial sites)

Analysis of the wind roses (Figure 1-2) show that Totara Street, Whareroa Marae and Bridge Marina are biased to industry whilst Sulphur point is biased to port activities. The furtherst station, Rata Street does not appear to have a strong industrial footprint, but does reflect the main source of SO_2 emissions which are related to Port activities and shipping. The average concentration of SO_2 since January 1, 2020 to end of May 2020[3] from Rata Street, Sulphur Point and Rail Yard South are detailed in Table 1-1 for various percentiles for a 10-minute period, 1-hour and 24-hour period. The 1-hour 99.9th percentile from Rata street (47 µg/m^3) is comparable to the modelled and emission inventory for back ground SO_2 within the TMMA (see Table 1-2). Although, Table 1-2 does not include modelled concentrations of domestic heating, port activities and outdoor burning, their combined contribution is small. There is still good agreement between the data derived from the Rata Monitor and the background values that were modelled.

Of the three monitoring stations, Rata station was determined to be the best 'background' station as it was the least influenced by industry. The 98th percentile limit of 24 µg/m^3 was determined to be a suitable, but not too conservative background value to use for all 1-hour averages. The 24-hour average from Rata Street was 16 µg/m^3 and was the value used to represent the 24-hour background.

Table 1-1. Average, minimum, maximum SO_2 concentrations (µg/m^3) for three BOPRC monitoring stations that did not record a strong industrial signal.

SO2 (µg/m^3)	10-minute				1-hour					24-hour
BOPRC Monitor	Max	99.9%	99.5%	98%	Max	99.9%	99.5%	98%	95%	Max
Rata Street	81	53	39	26	58	47	35	**24**	18	**16**
Rail Yard South	107	50	31	19	62	42	28	17	12	17
Sulphur Point	141	76	44	25	99	65	41	23	12	18

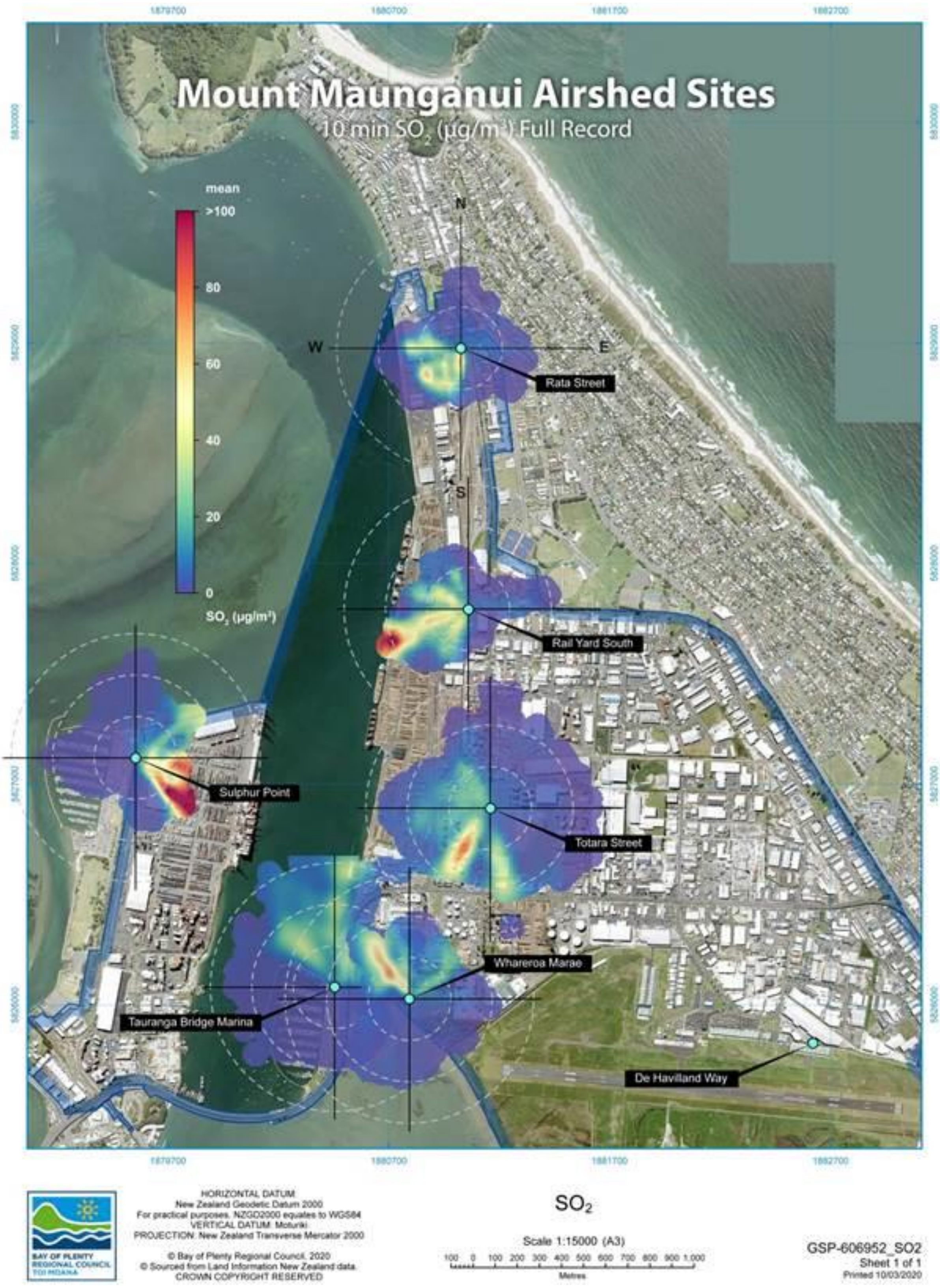
Table 1-2. Summary table of SO_2 background annual emission rates in t/yr[4][5] and 1-hour modelled (2014-2016) concentrations for 2015 and 2016 at each of the three of the BOPRC monitoring stations.

Source of SO_2 (excl industry)	Tonnes per year	Totara		Marae		Marina	
		1-hour Modelled SO_2 (µg/m^3)					
		2015	2016	2015	2016	2015	2016
Shipping	745	34	19	40	22	45	28
White Island	36,500	2	2	2	2	2	2
Airport	1.5	0.3	0.2	0.2	0.2	0.2	0.1
Domestic heating	5						
Port Activities	1						
Motor vehicles	1						
Outdoor burning	1						

[3] The background monitoring data from Rata street is representative of low Sulphur fuel (0.5%) as per New Zealand MARPOL commitment which requires all in-coming and out-going vessels to comply.
[4] Environet. Tauranga Air Emissions Inventory. 2018
[5] Addendum Document on the Comparison of two Independent SO_2 Emission Inventories for the Tauranga (2018) and Tauranga / Mount Maunganui Area (2014-2016).

Figure 1-1. Bay of Plenty Regional Council monitoring stations within the TMMA.

Figure 1-2. Bay of Plenty Regional Council 10-minute SO_2 wind roses for each monitoring station within the TMMA.



1.4 Proposed Maximum Upper Limits

1.4.1.1 Ballance Agri Nutrients

Ballance has proposed an upper SO_2 limit of 40 kg/hr from the Acid Plant. However, it is proposed that a secondary consent limit be applied which limits (87 hours, 1%) the amount of time that the Acid Plant can emit in the range of 30 – 40 kg/hr. Current operations show that since 2017 Ballance only emitted 12 hours in this range, and therefore this limit should be easily met.

Ballance has not proposed any adjustments to the Manufacture stack (Acidulation Plant) whose current maximum consent limit is 10 kg/hr. It is recommended that an upper maximum not to exceed limit of 7 kg/hr for the Acidulation Plant with no more than 5% of the time in the upper range of 5 – 7 kg/hr. This is consistent with the bulk (95%) of the operations discharging at < 5 kg/hr as per the BOPRC\ASG model assessment and current operations. A limit on the percent of time that the Acidulation Plant can emit at its upper limit is reasonable due to the potentially high SO_2 concentrations within the plant and at the plant boundary. It is recommended that Ballance conduct monitoring on site.

1.4.1.2 Lawter NZ Limited

Lawter has not proposed any reductions to its current maximum consent limit of 74 kg/hr. Both the AEEs are supportive of this current 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. In addition to supporting the maximum current upper limit Golder has suggested an additional percentage limit of 5-10% (438 hours to 876 hours) 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% (2190 hours) 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.

However, these new proposed limits do not suggest a decrease in SO_2 emissions, but instead allow for an increase in emissions > 50 kg/hr, when compared to current operations which are mostly below this limit. Further, the proposed new limits of the AEEs are not represented by any dispersion modelling. The BOPRC CEM modelling used current operations for 2014-2016 which were lower than the new proposed limits recommended by the AEEs.

Dispersion modelling has shown that there are exceedances of the 10-minute WHO, 1-hour NES and 24-hour assessment criteria beyond the boundary of the plant at the proposed 74 kg/hr emission limit when assessed on its own. ASG has conducted further dispersion modelling which shows that the maximum emission limit which produces no exceedances beyond the plant boundary (when assessed on its own) is 58 kg/hr. Therefore 58 kg/hr forms the basis of the first cumulative impact assessment conducted below (Scenario 1).

2. Cumulative Impact Assessment

Table 2-1 shows the 4 scenarios that were considered for cumulative analysis, each of the Scenarios is briefly described below, where Scenario 1, the starting point, is the limit at which the industries produce no exceedances beyond their plant boundaries, when assessed on their own.

In addition to four scenarios, the AQIA and AEE proposed maximum emission limits of; Acid Plant (40 kg/hr), Manufacture Plant (10 kg/hr), WMNZ (1 kg/hr) and Lawter (74 kg/hr) has been provided and are shown in Appendix A for the maximum 1-hour maximum and 1-hour 99th percentile NES and 24-hour assessment criteria. Exceedances can be seen to occur beyond the plant boundaries for all assessment criteria.

Table 2-1. Scenarios developed for the SO_2 Cumulative Impact Assessment

	Scenario 1[*1]	Scenario 2	Scenario 3	Scenario 4
Description	Ballance currently proposed and current operation. Lawter will need to accept new lower max limit No exceedances of any NES beyond plant boundary when each facility assessed on their own. Lawter - reduction of 16 kg/hr from current max Secondary consent limits are most likely necessary	Ballance currently proposed and current operation. Lawter will need to accept new lower max limit No exceedances of any NES beyond plant boundary when each facility assessed on their own. Lawter - reduction of 24 kg/hr from current max Secondary consent limits are most likely necessary	Ballance currently proposed and current operation. Lawter will need to accept new lower max limit No exceedances of any NES beyond plant boundary when each facility assessed on their own. Lawter - reduction of 29 kg/hr from current max Secondary consent limits are most likely necessary.	Ballance currently proposed and current operation. Lawter will need to accept new lower max limit No exceedances of any NES beyond plant boundary when each facility assessed on their own. Lawter - reduction of 34 kg/hr from current max No secondary limits are needed
Acid Plant	40 kg/hr	40 kg/hr	40 kg/hr	30 kg/hr
Manufacture Stack	10 kg/hr[*2]	10 kg/hr[*2]	10 kg/hr[*2]	5 kg/hr
WMNZ	1 kg/hr	1 kg/hr	1 kg/hr	0.8 kg/hr
Lawter	58 kg/hr	50 kg/hr	45 kg/hr	40 kg/hr
		Secondary Maximum Emission Limitations		
Acid Plant	(87 hrs 30-40kg/hr)	(87 hrs 30-40kg/hr)	(87 hrs 30-40kg/hr)	If maximum consent capped at these levels unlikely any secondary consent limits will be necessary
Manufacture Stack	(438 hrs 5-7kg/hr)	(438 hrs 5-7kg/hr)	(438 hrs 5-7kg/hr)	
WMNZ[*3]	(876 hrs 0.8-1kg/hr)	(876 hrs 0.8-1kg/hr)	(876 hrs 0.8-1kg/hr)	
Lawter	(87 hrs 50-58kg/hr) (262 hrs 40-50kg/hr)	(262 hrs 40-50kg/hr)	(262 hrs 40-45kg/hr)	

[*1] Scenario 1 is the starting point of the cumulative assessment. With an upper limit of 58 kg/hr, Lawter does not produce any exceedance beyond its plant boundary.
[*2] Recommend upper limit of 7kg/hr for Manufacture stack based on modelling and current operations, secondary hourly limits recommended, concern for workers on site.
[*3] WMNZ is a small producer of SO_2 compared to its neighbours. However, WMNZ is responsible for exceedances of the 24-hour criteria on its western border with Ballance. It is recommended that WMZN consider some reduction of SO_2 and recommends on-site monitoring in the vicinity of the thermal flue.

2.1.1 Scenario 1

Scenario 1 is based on maximum emission limits where Lawter does not produce any exceedances of the 1-hour NES, or 24-hour assessment criteria beyond their plant boundary, when assessed alone. At 40 kg/hr from the Acid Plant, which is the proposed new limit put forward by Ballance, a few exceedances beyond the western plant boundary do occur for the 1-hour 99.9th NES and 24-hour criteria, when assessed individually.

This scenario uses the proposed Ballance maximum consent level of 40 kg/hr for the Acid Plant and 10 kg/hr for the Manufacture stack. Lawter has not proposed a reduction from its maximum current consent limit of 74 kg/hr, so it has been assessed at a maximum limit of 58 kg/hr which is the level at which no exceedances occur beyond the plant boundary. WMNZ has been assessed at its current consent limit of 1 kg/hr.

At these consent limits modelling returned the following peak concentrations when assessed over three years (2014 – 2016). (AC is assessment criteria).

H1H (1-hour maximum)	-	922.35 µg/m^3 in 2016 (AC is 570 µg/m^3)
H9H (1-hour 99.9th percentile)	-	545.60 µg/m^3 in 2016 (AC is 350 µg/m^3)
24H (24-hour)	-	312.38 µg/m^3 in 2016 (AC is 120 µg/m^3)

Figure 2-1, Figure 2-2 and Figure 2-3 show the locations for each of the assessment criteria where SO_2 exceedances occur. The cumulative impact shows exceedances of the 1-hour NES of (570 µg/m^3) beyond the plant boundary. These are limited to within 80m of the western side of the Ballance plant boundary and on the eastern boundary of WMNZ and Ballance at the 99.9th percentile limit. The 24-hour cumulative impact also shows exceedances 80m or so beyond the plant boundaries to the west of Ballance and east of Lawter boundaries. Further, there are a number of exceedances of the 24-hour criteria at the shared plant boundary between WMNZ and Ballance.

If all three facilities were emitting at their maximum consented emission limits simultaneously then exceedances can be expected to occur beyond the plant boundary. However, the chance of these industries emitting concurrently at these maximum levels is low. Secondary limitations of;

Acid Plant	-	87 hrs @ 30 – 40 kg/hr
Manufacture Plant	-	438 hrs @ 5 – 7 kg/hr (and a recommended upper limit of 7kg/hr)
Lawter	-	87 hrs @ 50 – 58 kg/hr and
		262 hrs @ 40 – 50 kg/hr
WMNZ	-	876 hrs @ 0.8 - 1kg/hr

will ensure that the number of hours emitting close to the upper levels is kept to a minimum. Note that neither WMNZ nor the Manufacture stack cause exceedances beyond their respective plant boundaries when emitting at current consent limits of 1 kg/hr and 10 kg/hr, but high concentrations occur on each site and on the border between WMNZ and Ballance. Emission limits are recommended for the Manufacture stack in line with current operations and previous modelling that was conducted. Emission limits are also recommended for WMNZ due to the high concentrations that occur at its boundary at 1kg/hr.

2.1.2 Scenario 2

Scenario 2 is the same as Scenario 1 above for the Acid Plant, Manufacture Plant and WMNZ but Lawter contribution has been further reduced from 58 kg/hr to 50 kg/hr. Similarly, to Scenario 1 above none of the facilities produce any exceedances of the 1-hour NES, or 24-hour criteria beyond their current plant boundaries when assessed individually.

This scenario uses the proposed Ballance maximum consent level of 40 kg/hr for the Acid Plant and 10 kg/hr for the Manufacture stack, 1 kg/hr for WMNZ and 50 kg/hr for Lawter.

At these consent limits modelling returned the following peak concentrations when assessed over three years (2014 – 2016).

H1H	-	922.35 µg/m^3 in 2016 (AC is 570 µg/m^3)
H9H	-	545.60 µg/m^3 in 2016 (AC is 350 µg/m^3)
24H	-	299.95 µg/m^3 in 2016 (AC is 120 µg/m^3)

Figure 2-4, Figure 2-5 and Figure 2-6 show the locations for each of the NES assessment criteria where SO_2 exceedances occur. The cumulative impact shows exceedances of the 1-hour NES of (570 µg/m3) beyond the plant boundary. These are limited to within 80m of the western side of the Ballance plant boundary, and on the eastern boundary between WMNZ and Ballance at the 99.9th percentile limit. The location of the NES exceedances is similar for the 24-hour average, i.e., within 80m of the west boundary of the Ballance plant and on the border between WMNZ and Ballance. At these maximum consent levels, secondary hourly limits are recommended;

Acid Plant	-	87 hrs @ 30 – 40 kg/hr
Manufacture Plant	-	438 hrs @ 5 – 7 kg/hr (and a recommended upper limit of 7kg/hr)
Lawter	-	262 hrs @ 40 – 50 kg/hr
WMNZ	-	876 hrs @ 0.8 - 1kg/hr

If all three facilities were emitting at their maximum consented emission limits concurrently then exceedances can be expected to occur beyond the plant boundary, especially west of the Ballance boundary. These exceedances are the combined contribution of Lawter and the Acid Plant under a weakly unstable atmosphere.

However, the chance of these industries emitting simultaneously at these upper emission levels is low. Secondary hourly limitations will ensure that the number of hours at the upper levels is kept to a minimum.

2.1.3 Scenario 3

Scenario 3 is the same as Scenario 1 above for the Acid Plant, Manufacture Plant and WMNZ but Lawter contribution has been further reduced from 58 kg/hr to 45 kg/hr, i.e., 5 kg less per hour than Scenario 2. At these maximum limits none of the facilities produce any exceedances of the 1-hour NES, or 24-hour criteria beyond their current plant boundaries when assessed individually.

This scenario uses the proposed Ballance maximum consent level of 40 kg/hr for the Acid Plant and 10 kg/hr for the Manufacture stack, 1 kg/hr for WMNZ and 45 kg/hr for Lawter.

At these consent limits modelling returned the following peak concentrations when assessed over three years (2014 – 2016).

H1H	-	922.35 µg/m^3 in 2016 (AC is 570 µg/m^3)
H9H	-	545.60 µg/m^3 in 2016 (AC is 350 µg/m^3)
24H	-	292.17 µg/m^3 in 2016 (AC is 120 µg/m^3)

Figure 2-7, Figure 2-8 and Figure 2-9 show the locations for each of the NES SO_2 exceedances for 1-hour maximum, 1-hour 99.9th percentile and the 24-hour average. The cumulative impact still sows some exceedances of the 1-hour NES of (570 µg/m^3) well beyond the plant boundary. These are limited to within 80m of the western side of the Ballance plant boundary and on the eastern boundary of WMNZ and Ballance at the 99.9th percentile limit. The location of the 24-hour criteria exceedances is limited to within 80m of the eastern boundary of Ballance and focussed around the border between WMNZ and Ballance. Secondary, hourly emission limits are recommended;

Acid Plant	-	87 hrs @ 30 – 40 kg/hr
Manufacture Plant	-	438 hrs @ 5 – 7 kg/hr (and a recommended upper limit of 7kg/hr)
Lawter	-	262 hrs @ 40 – 50 kg/hr
WMNZ	-	876 hrs @ 0.8 - 1kg/hr

If all three facilities were emitting simultaneously at these maximum emission limits then exceedances can be expected to occur beyond the plant boundaries primarily on the western side of Ballance plant which is largely the combined contribution of both the Acid Plant and Lawter. Like the other scenarios the chance of these industries emitting simultaneously at these maximum levels is low. Secondary limitations will ensure that the number of hours at the upper levels is kept to a minimum.

2.1.4 Scenario 4

Scenario 4 is a reduction of all the current and proposed maximum emission limits for each of the industrial sites. Here the Acid Plant has been reduced from 40 kg/hr to 30 kg/hr. The Manufacture Stack has been reduced from 10 kg/hr to 5 kg/hr. SO_2 emissions from WMNZ has been reduced 20% to 0.8 kg/hr, and Lawter has seen a further reduction of 5 kg/hr from Scenario 3 to just 40 kg/hr which is a 54% reduction from the current (and proposed) maximum limit.

At these consent limits modelling returned the following peak concentrations when assessed over three years (2014 – 2016).

H1H	-	697.56 µg/m^3 in 2016 (AC is 570 µg/m^3)
H9H	-	414.68 µg/m^3 in 2016 (AC is 350 µg/m^3)
24H	-	237.63 µg/m^3 in 2016 (AC is 120 µg/m^3)

Figure 2-10, Figure 2-11 and Figure 2-12 show the locations for each of the NES SO_2 exceedances. The cumulative impact shows some exceedances of the 1-hour NES of (570 µg/m^3) at the eastern plant boundary, between WMNZ and Ballance. But there are no exceedances beyond the plant boundary. Similarly, there are no exceedances of the 1-hour 99.9th percentile beyond the plant boundary.   There are a few exceedances of the 24-hour criteria beyond the eastern Ballance plant boundary and there are exceedances of the 24-hour criteria at the eastern WMNZ boundary. These are mostly contributed to the Manufacture stack and WMNZ thermal flue.   However, at these maximum consent levels, no secondary hourly consent limits are necessary.

Further at these emission limits all three facilities can be emitting at their limits simultaneously and no exceedances of the NES 1-hour assessment criteria is expected to occur beyond any of the plant boundaries.   There are a few exceedances beyond the Ballance plant boundary for the 24-hour average, and there are still 24-hour exceedances on the WMNZ boundary. SO_2 concentrations are consistently the highest along the WMNZ\Ballance border and monitoring close to the Thermal flue is recommended.

Figure 2-1. Scenario 1 – Locations showing the exceedances of the maximum 1-hour modelled SO_2 concentrations ($\mu g/m^3$) where Acid Plant (40 kg/hr), Manufacture Plant (10 kg/hr), WMNZ (1 kg/hr), Lawter (58 kg/hr).

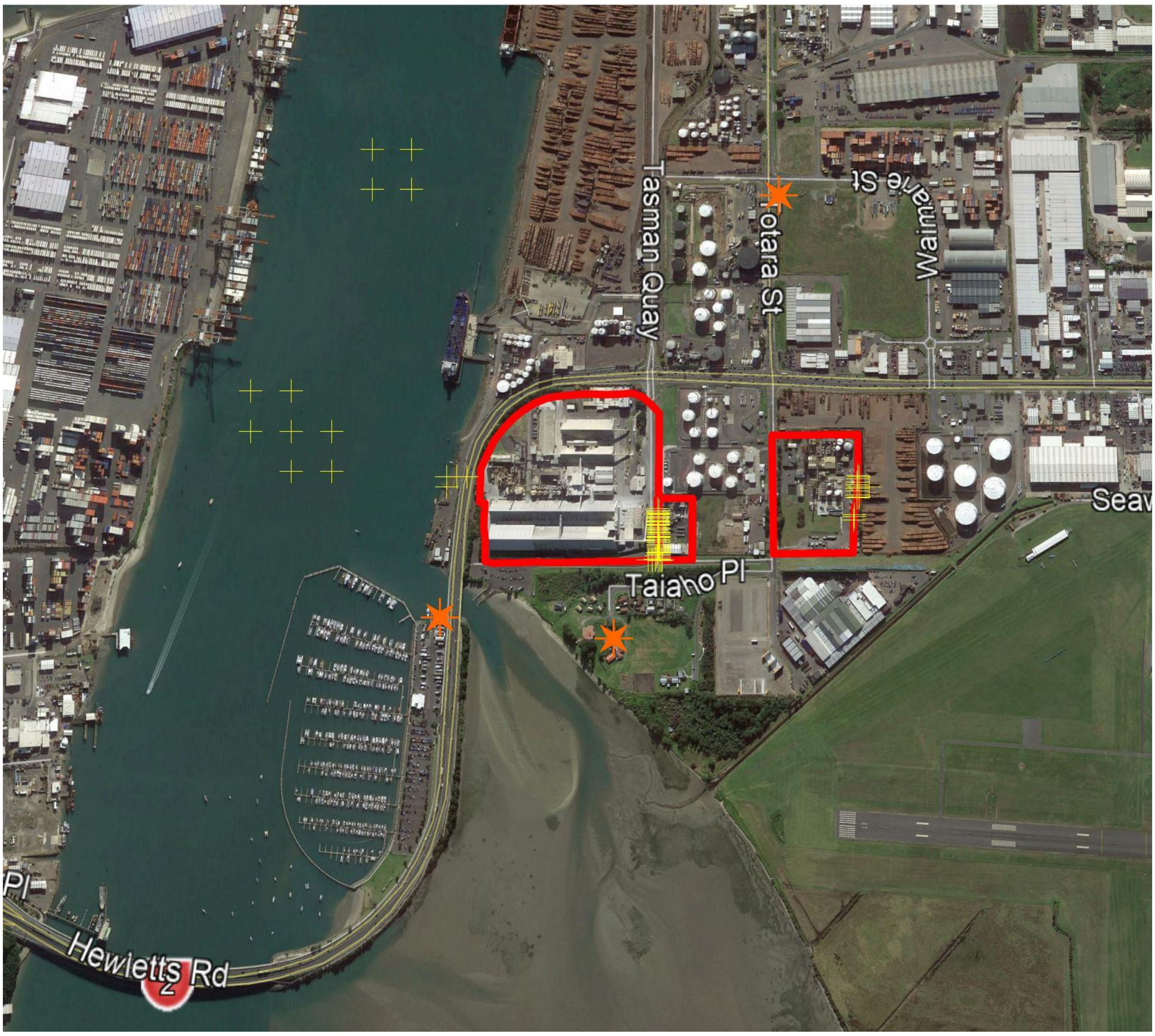


Figure 2-2. Scenario 1 – Locations showing the exceedances of the 99.9th percentile 1-hour modelled SO_2 concentrations (µg/m^3) where Acid Plant (40 kg/hr), Manufacture Plant (10 kg/hr), WMNZ (1 kg/hr), Lawter (58 kg/hr).

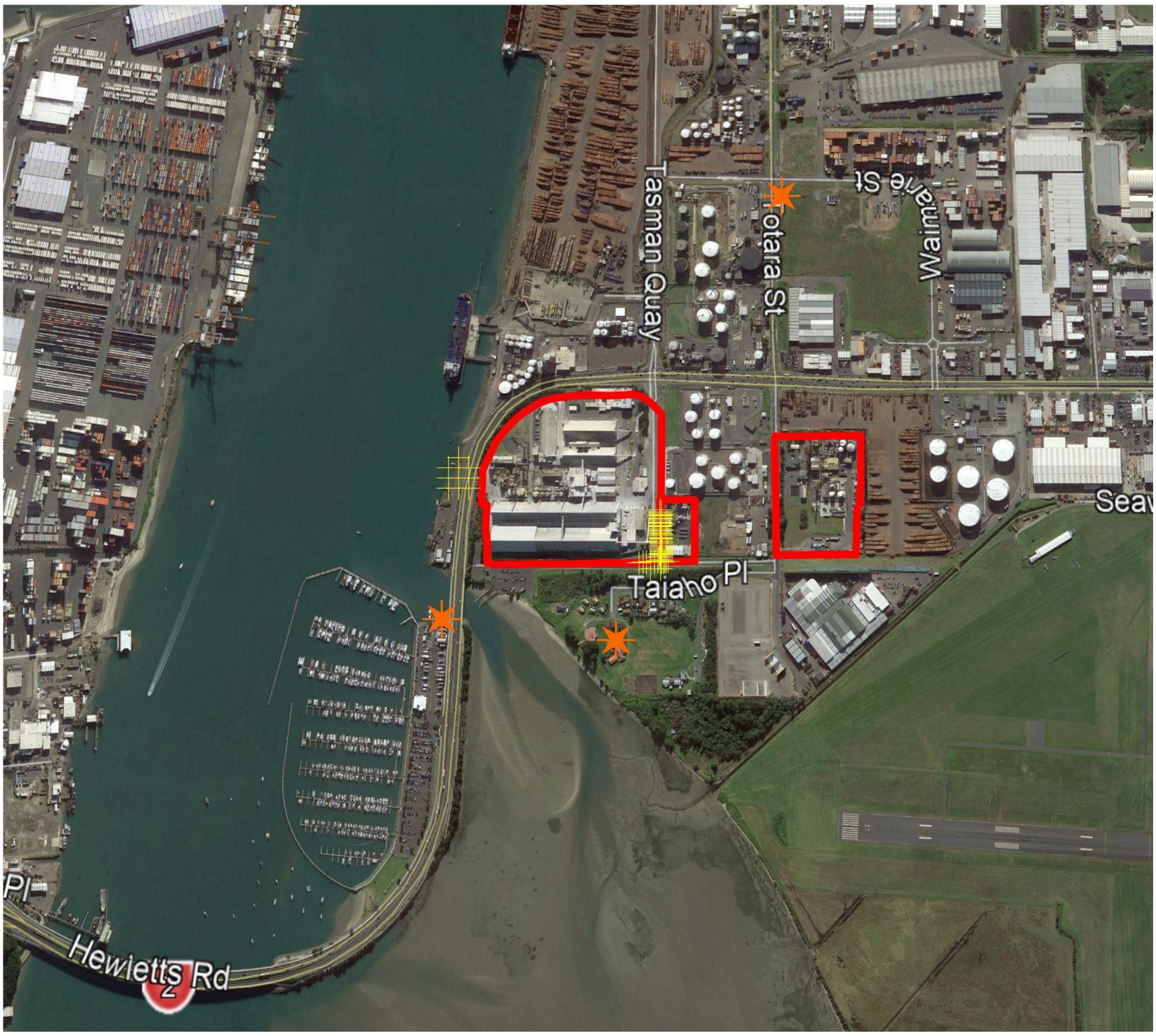


Figure 2-3. Scenario 1 – Locations showing the exceedances of the 24-hour modelled SO_2 concentrations ($\mu g/m^3$) where Acid Plant (40 kg/hr), Manufacture Plant (10 kg/hr), WMNZ (1 kg/hr), Lawter (58 kg/hr).

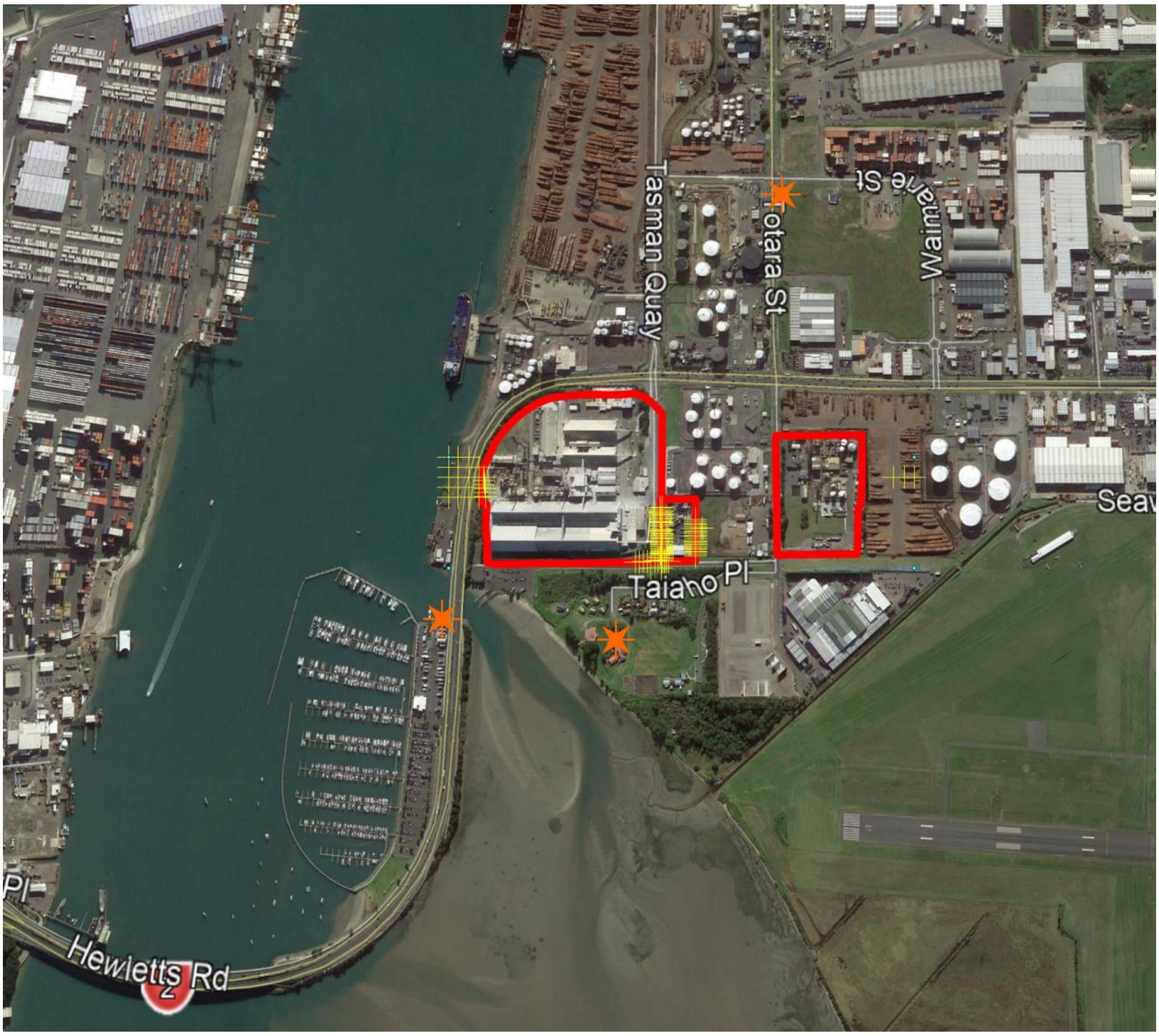


Figure 2-4. Scenario 2 – Locations showing the exceedances of the maximum 1-hour modelled SO_2 concentrations ($\mu g/m^3$) where Acid Plant (40 kg/hr), Manufacture Plant (10 kg/hr), WMNZ (1 kg/hr), Lawter (50 kg/hr).

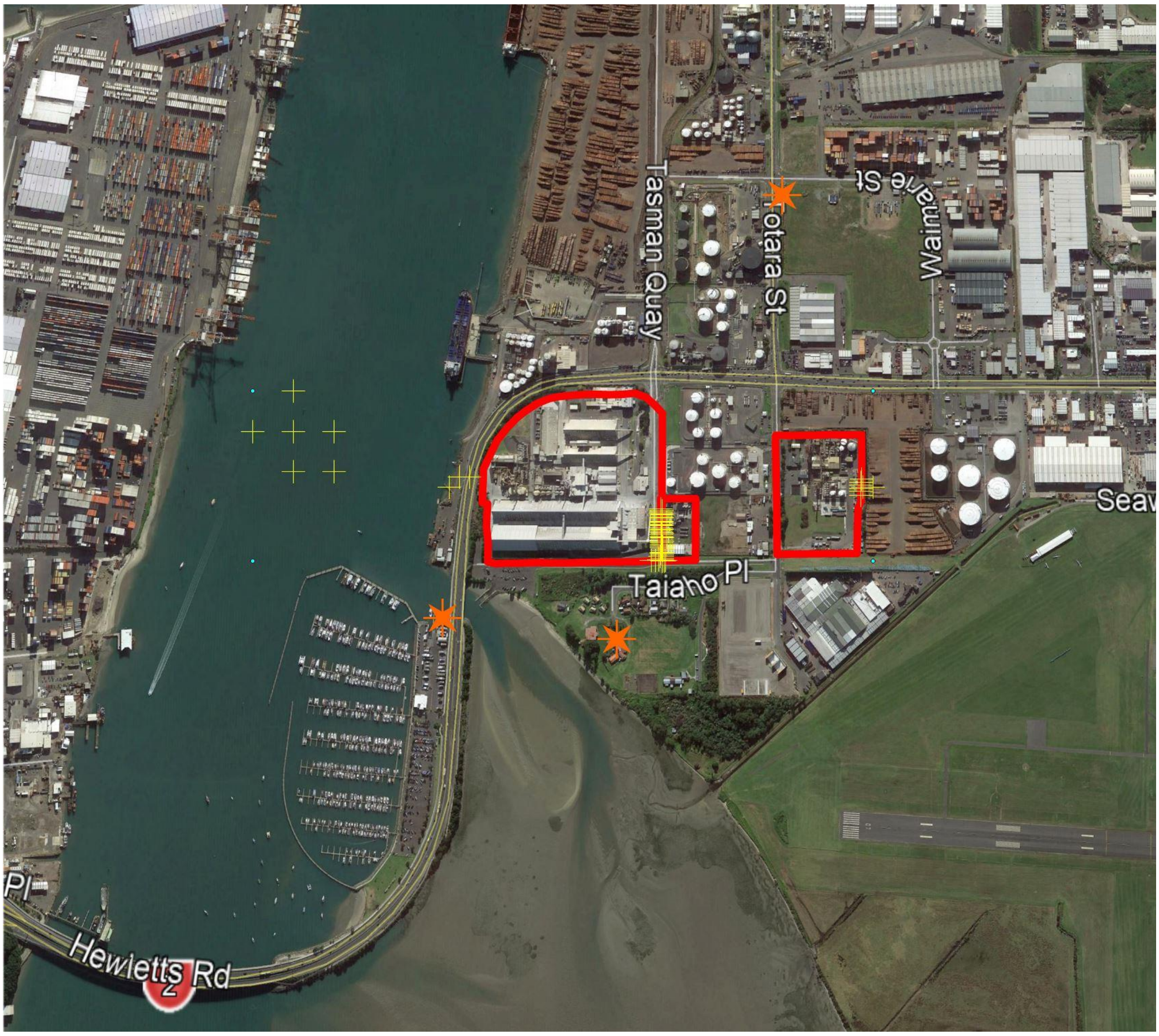


Figure 2-5. Scenario 2 – Locations showing the exceedances of the 99.9th percentile 1-hour modelled SO_2 concentrations (µg/m^3) where Acid Plant (40 kg/hr), Manufacture Plant (10 kg/hr), WMNZ (1 kg/hr), Lawter (50 kg/hr).

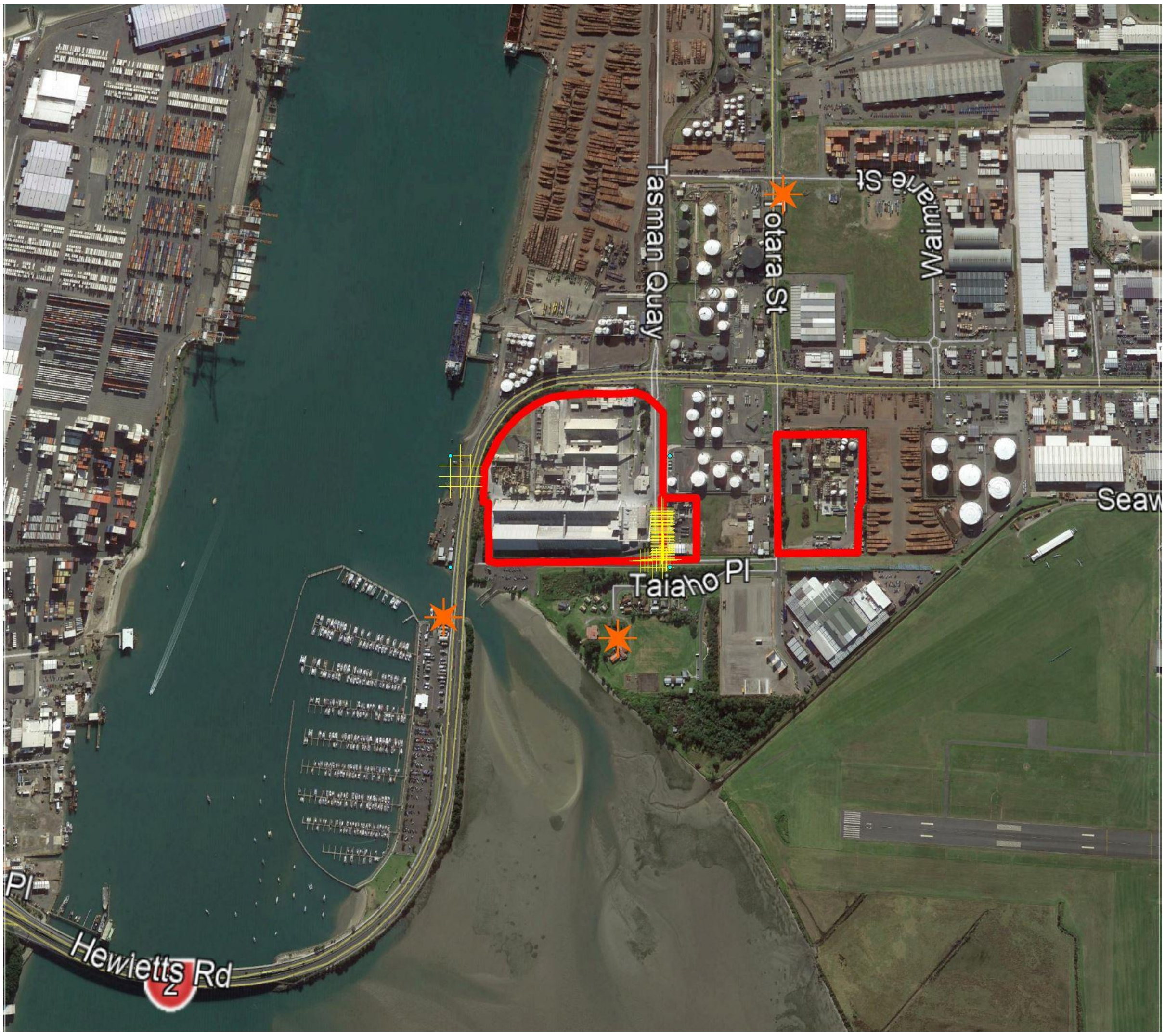


Figure 2-6. Scenario 2 – Locations showing the exceedances of the 24-hour modelled SO_2 concentrations ($\mu g/m^3$) where Acid Plant (40 kg/hr), Manufacture Plant (10 kg/hr), WMNZ (1 kg/hr), Lawter (50 kg/hr).

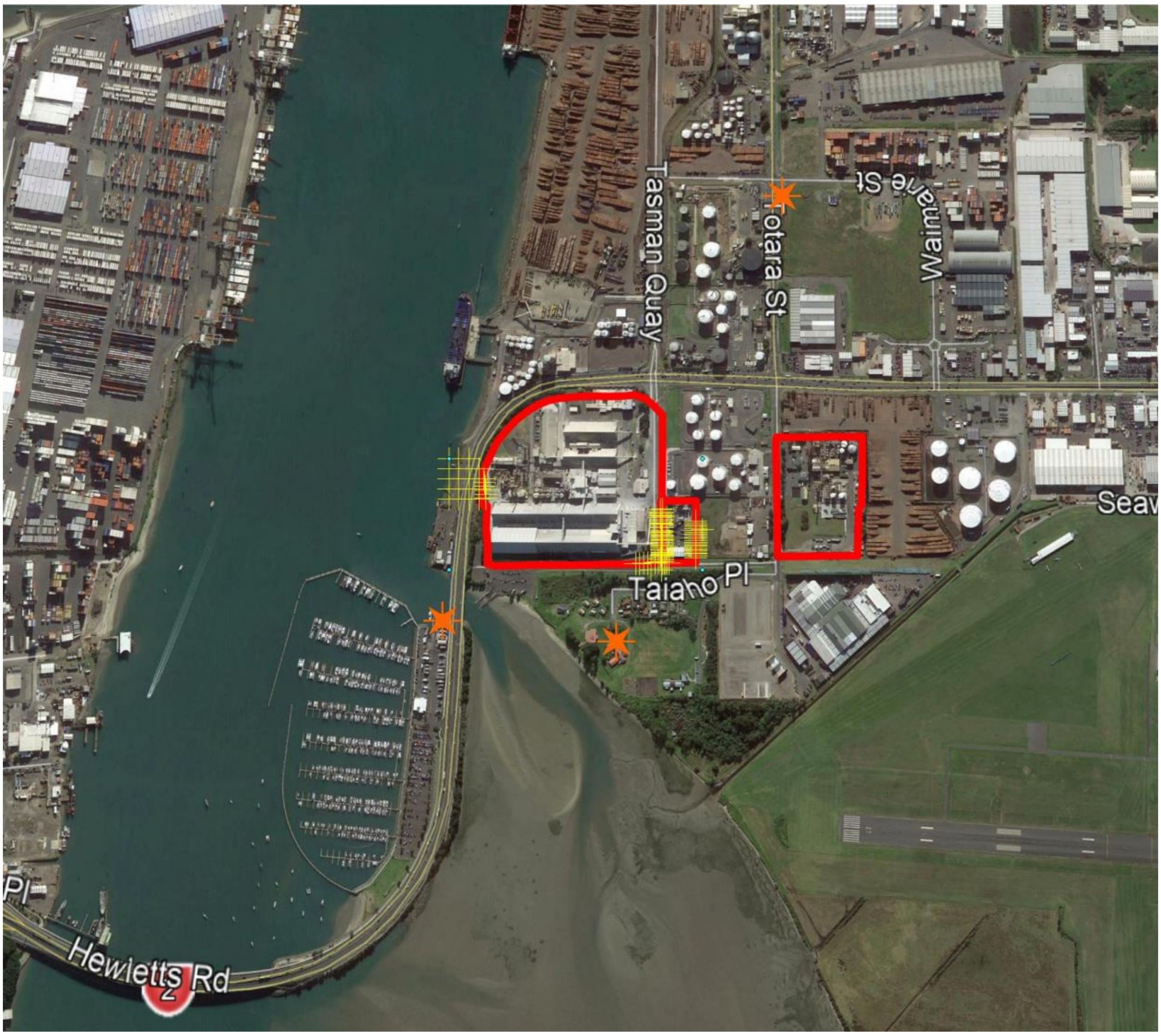


Figure 2-7. Scenario 3 – Locations showing the exceedances of the maximum 1-hour modelled SO_2 concentrations ($\mu g/m^3$) where Acid Plant (40 kg/hr), Manufacture Plant (10 kg/hr), WMNZ (1 kg/hr), Lawter (45 kg/hr).

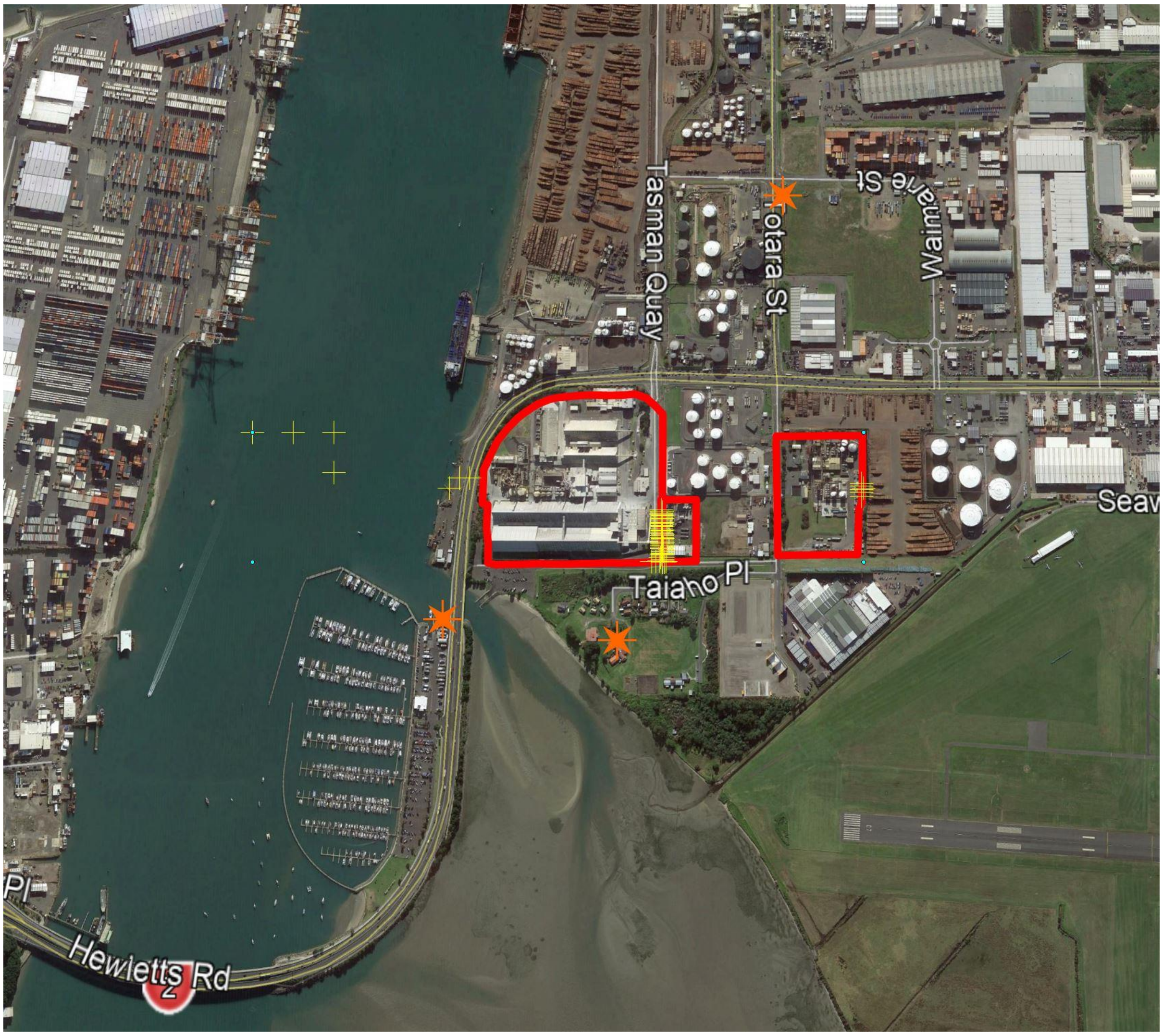


Figure 2-8. Scenario 3 – Locations showing the exceedances of the 99.9th percentile 1-hour modelled SO_2 concentrations (µg/m^3) where Acid Plant (40 kg/hr), Manufacture Plant (10 kg/hr), WMNZ (1 kg/hr), Lawter (45 kg/hr).

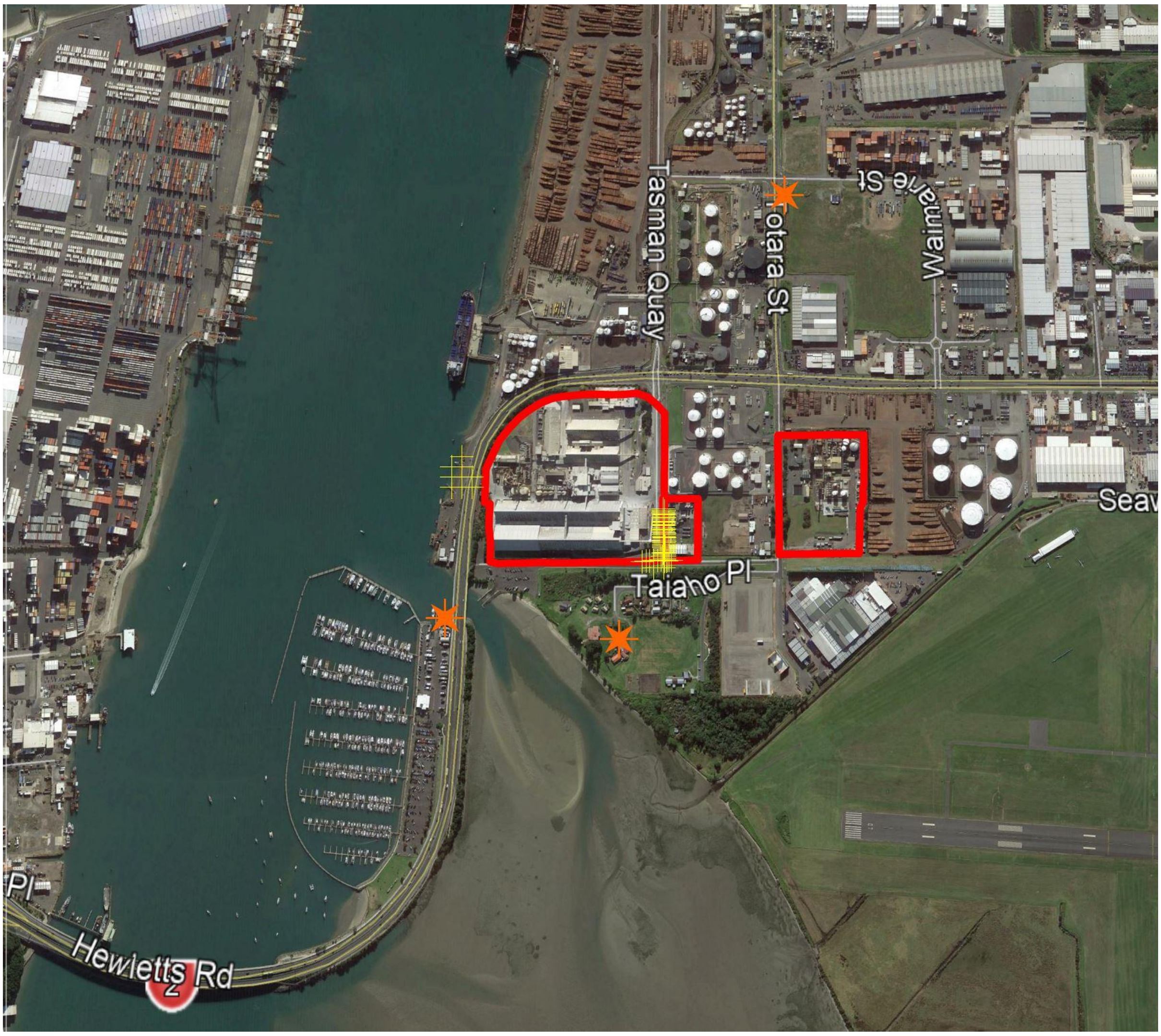


Figure 2-9. Scenario 3 – Locations showing the exceedances of the 24-hour modelled SO_2 concentrations ($\mu g/m^3$) where Acid Plant (40 kg/hr), Manufacture Plant (10 kg/hr), WMNZ (1 kg/hr), Lawter (45 kg/hr).

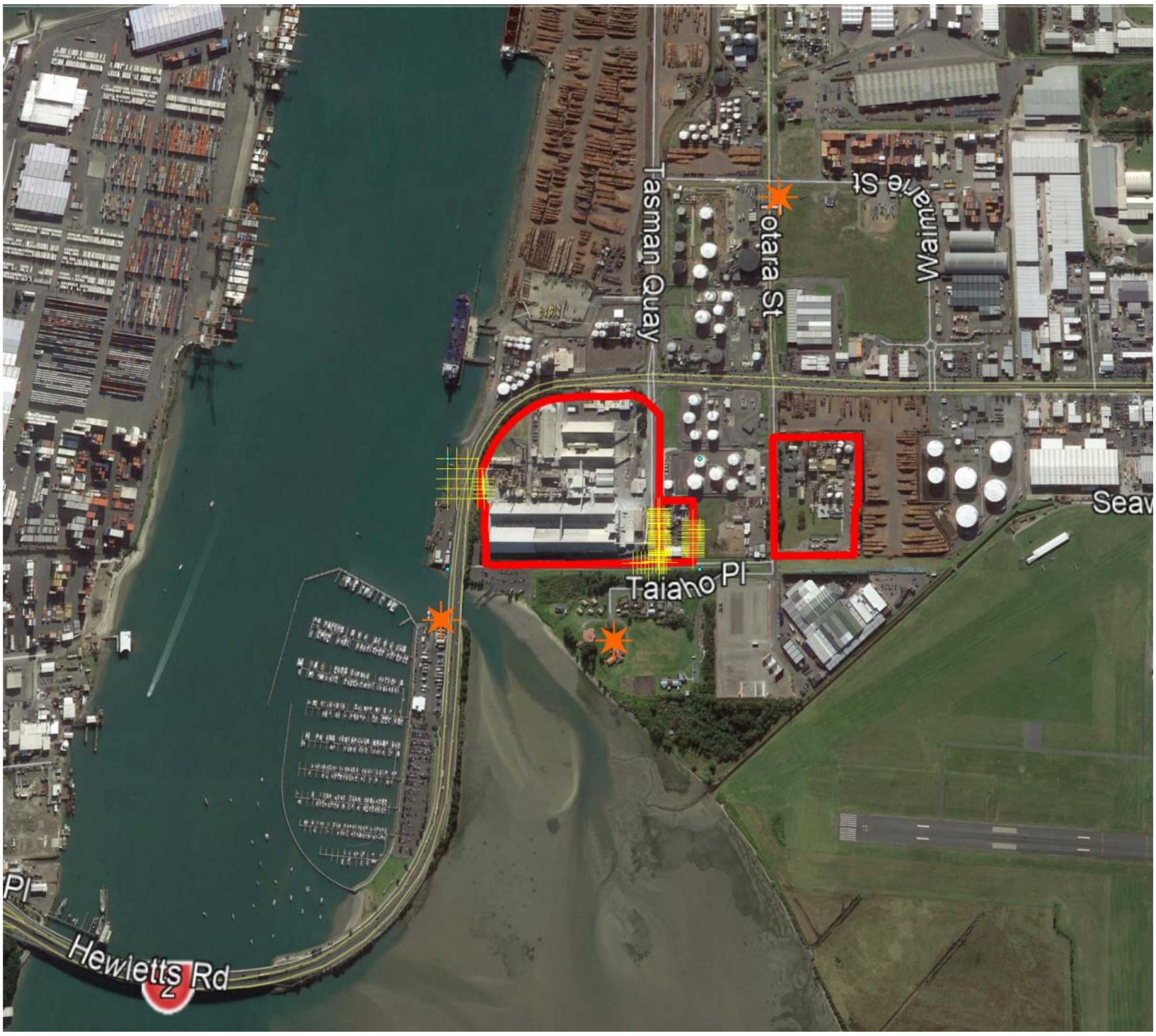


Figure 2-10. Scenario 4 – Locations showing the exceedances of the maximum 1-hour modelled SO_2 concentrations (µg/m^3) where Acid Plant (30 kg/hr), Manufacture Plant (5 kg/hr), WMNZ (0.8 kg/hr), Lawter (40 kg/hr).

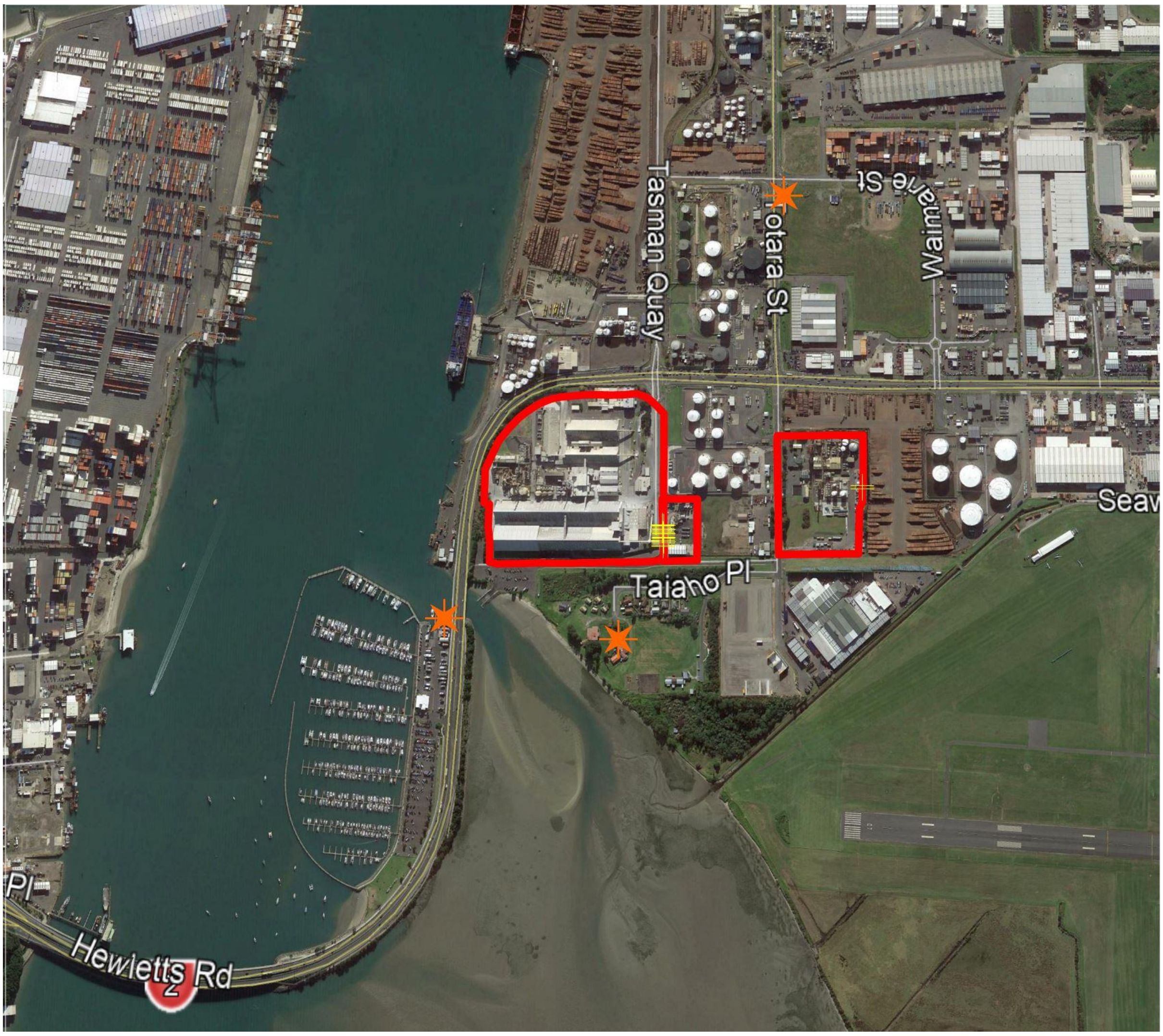


Figure 2-11. Scenario 4 – Locations showing the exceedances of the 99.9th percentile 1-hour modelled SO_2 concentrations ($\mu g/m^3$) where Acid Plant (30 kg/hr), Manufacture Plant (5 kg/hr), WMNZ (0.8 kg/hr), Lawter (40 kg/hr).

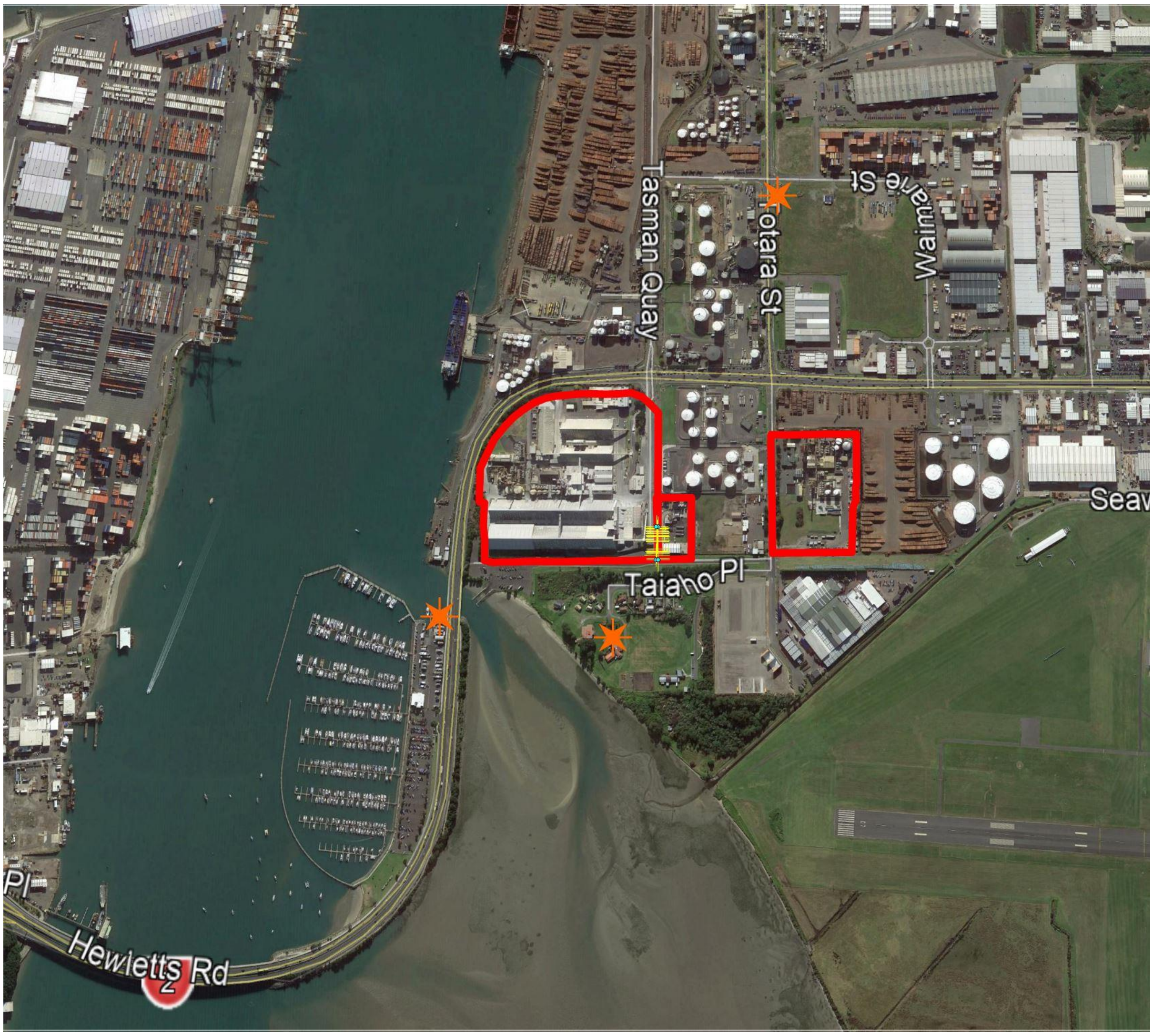
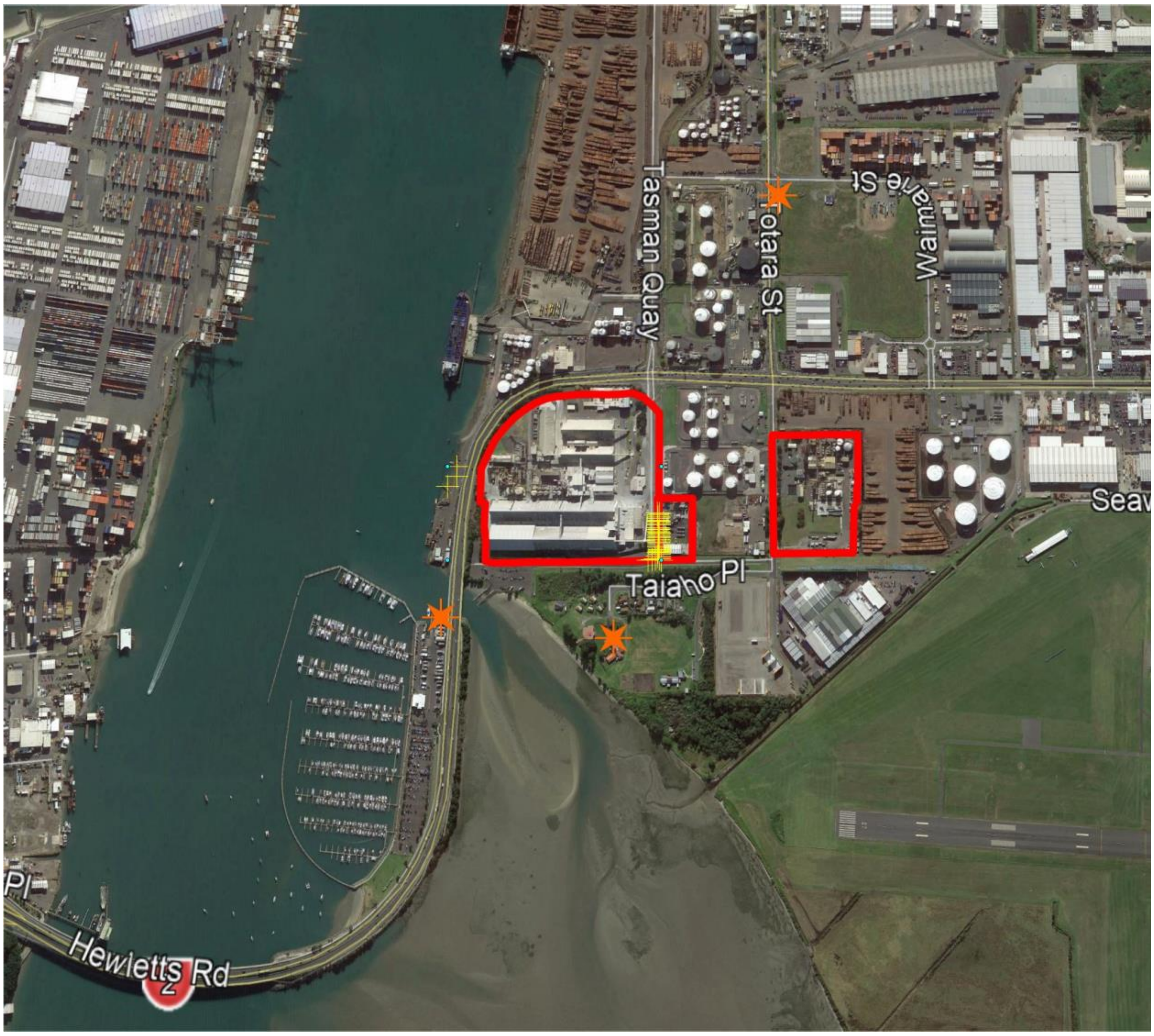


Figure 2-12. Scenario 4 – Locations showing the exceedances of the 24-hour modelled SO_2 concentrations (µg/m^3) where Acid Plant (30 kg/hr), Manufacture Plant (5 kg/hr), WMNZ (0.8 kg/hr), Lawter (40 kg/hr).



2.2 Summary

The Air Impact Assessments conducted to date did not consider the modelled combined cumulative impact of each individual industrial facility, plus the background. A modelled cumulative impact assessment of SO_2 within the TMMA is necessary for the following reasons;

- The TMMA for SO_2 is considered 'full'
- Requirement of the RMA;
- The proposed new maximum emission limits put forward by Ballance (Acid Plant at 40 kg/hr and Manufacture stack at 10 kg/hr) and Lawter (74 kg/hr) produce exceedances of the 1-hour NES and 24-hour SO_2 assessment criteria beyond the plant boundaries when assessed individually.

The most reliable way to assess the cumulative contribution of SO_2 is through dispersion modelling. The New Zealand Good Practice Guide is not clear whether a single Background value is representative of all Background including nearby industry, or whether nearby industrial sources must be explicitly modelled and then summed in conjunction with the Background that excludes the industrial signal. In light of the vague GPG for assessing cumulative impacts, the cumulative assessment conducted in this Report has followed best international practice from the US EPA guidance on SO_2 for the Prevention of Significant Deterioration Program. This guidance recommends explicit modelling of each nearby individual SO_2 sources and then summing of these values to a representative Background value that is representative of SO_2 from other sources within the local air shed, or in this case the TMMA, where other background sources include SO_2 from White Island, Airport, shipping, port activities etc.

The Background SO_2 was determined from the BOPRC Rata monitoring station from 10-minute data from 1 January 2020 to 15 May 2020. The data is relevant to the current and future MARPOL environment of a 0.5% sulphur fuel content. The Rata monitor was the furtherst station from the industrial sites and did not show an industry signal. The 1-hour average background of 24 µg/m^3 (98th percentile), and a 24-hour average background of 16 µg/m^3 was added to the cumulative industrial totals.

The cumulative modelling considered 4 scenarios, where Scenario 1 was the proposed new lower maximum emission limit for the Acid Plant of 40 kg/hr and the maximum emission limit permissible for Lawter to ensure no exceedances occurred beyond the plant boundary when assessed on its own. Subsequent Scenario's 2 and 3 saw a reduction of Lawter maximum emission limit, but keeping Ballance and WMNZ emissions the same, (although recommendations are suggested for the Manufacture stack and WMNZ flue due to high concentrations on each site and along the shared plant boundary). Scenario 4 saw a reduction in all the emission limits (25% to 50%) across all the industries. Exceedances beyond the boundary occurred for all Scenarios except Scenario 4 for the 1-hour maximum NES of 570 µg/m$^{3.}$ These offsite exceedances mostly occurred to the north west of the Ballance Plant and are expected to be mostly contributed by Lawter and the Acid Plant under weakly unstable atmospheric conditions. 24-hour exceedances occur on the border between Ballance and WMNZ. The low height of the thermal vent on the WMNZ site produces exceedances of the 24-hour on its own. The concentrations are persistently high on the boundary between the facilities for all Scenarios analysed.

Scenario 1, 2 and 3 have shown that if all three facilities were emitting at their maximum consented emission limits, concurrently, then exceedances can be expected to occur beyond the plant boundaries. However, the chance of these industries emitting contemporaneously at these maximum levels is low. Secondary emission limitations are a good way to ensure that the number of hours at the upper levels is kept to a minimum.

3. Appendix A – Cumulative Impacts of AQIA Proposed Upper Limits

Note these upper limits are not recommended, but have been proposed by Industry.

Figure 3-1. Locations showing the exceedances of the 1-hour maximum modelled SO_2 concentrations (µg/m^3) where Acid Plant (40 kg/hr), Manufacture Plant (10 kg/hr), WMNZ (1.0 kg/hr), Lawter (74 kg/hr).

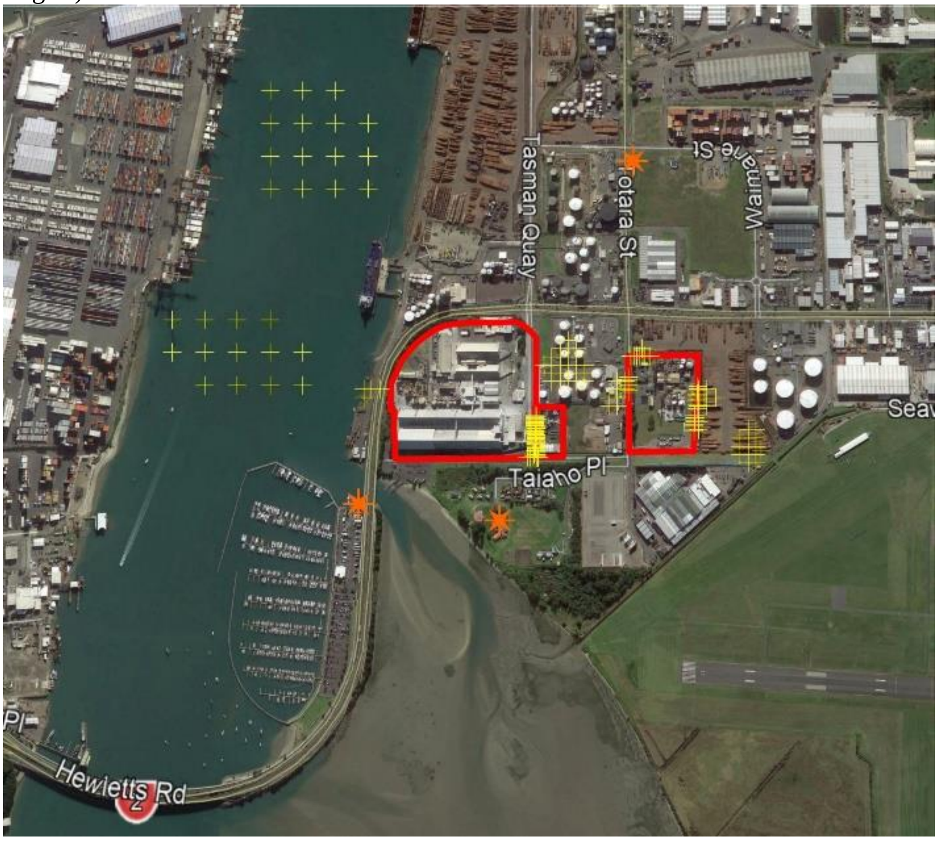


Figure 3-2. Locations showing the exceedances of the 1-hour 99.9th modelled SO_2 concentrations (µg/m^3) where Acid Plant (40 kg/hr), Manufacture Plant (10 kg/hr), WMNZ (1.0 kg/hr), Lawter (74 kg/hr).

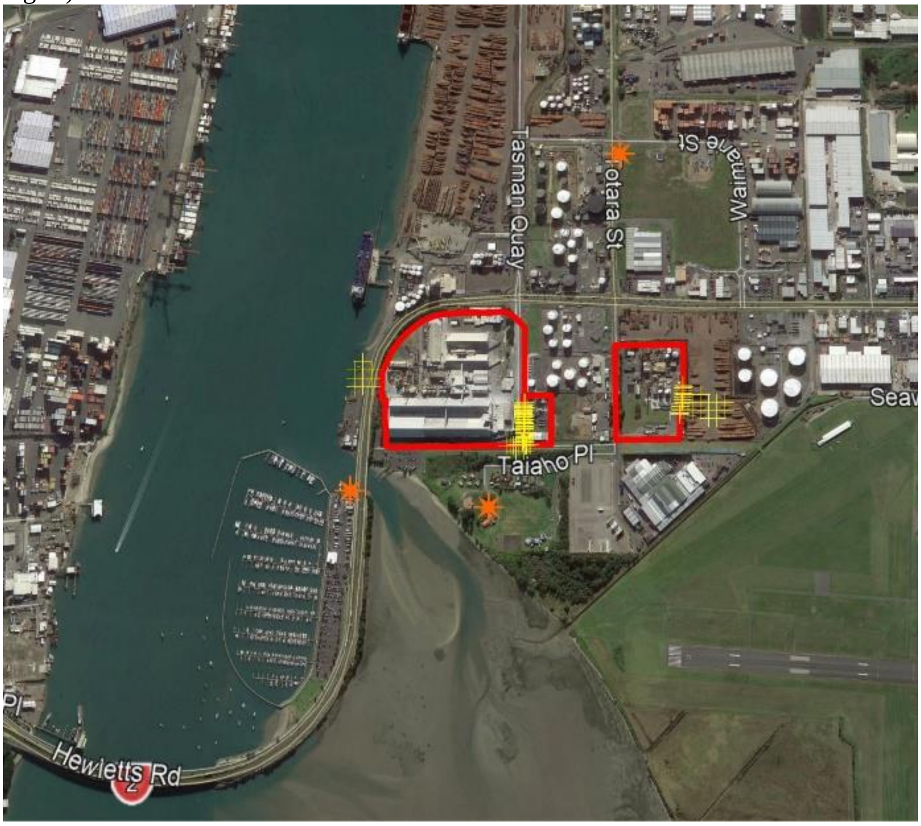


Figure 3-3. Locations showing the exceedances of the 24-hour modelled SO_2 concentrations (µg/m^3) where Acid Plant (40 kg/hr), Manufacture Plant (10 kg/hr), WMNZ (1.0 kg/hr), Lawter (74 kg/hr).

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