GLADSTONE NICKEL PROJECT ENVIRONMENTAL IMPACT STATEMENT SUPPLEMENT

Updated Air Quality Modelling Report

G

URS

Gladstone
Pacific Nickel LTD

Appendix G Air Quality

G.1 Revisions to plant design

The plant design for the Gladstone Pacific Nickel refinery in Gladstone has undergone some design modifications since the release of the Environmental Impact Statement. Alterations that have an affect on the air quality assessment have been addressed in this appendix. These changes affect the following plant operations:

- Sulphuric Acid plant. Additional sulphuric acid is needed in the process, requiring the addition of a new plant module and stack. Revised emission rates and stack characteristics have been used to remodel the emissions of SO_2 and sulphuric acid. Also, the additional stack has been evaluated to determine any effects on aviation safety, using the same methodology as used in the EIS;
- Ore transport from Marlborough. The option for ore to be transported from Marlborough by rail instead of by slurry pipeline has been evaluated for dust impacts;
- Ammonium Sulphate loading. The use of the Fisherman’s Landing wharf for export of ammonium sulphate (amsul) has been replaced by export through Barney Point. Revised dust impacts have been modelled for both the rail receival of Marlborough ore and the export of amsul through Barney Point;
- Increased import of sulphur. The increased acid requirements for the plant have resulted in additional imports of solid sulphur. The dust generated by these operations has been included in revised dispersion modelling for particulate matter;
- Revised emission rates for hydrogen sulphide. GPNL has committed to a reduction in emissions of hydrogen sulphide from the neutralisation vent. These emissions, with the associated odour emissions, have been addressed in revised modelling for the project; and
- Greenhouse gas assessment. The increased requirements for limestone in the process and changes to the requirements for generation and purchase of power at the refinery site have resulted in a change to the project’s greenhouse gas profile. A revised inventory of the greenhouse gas emissions has been prepared for the refinery.

G.2 Sulphuric acid plant

G.2.1 Revised emission rates for sulphur dioxide and sulphuric acid

More detailed design work for the supplementary report has revised the requirements for sulphuric acid in the process from 3.3 Mt/y to 4.5 Mt/y. To ensure that air quality impacts are not compromised due to the increased acid production rate, GPNL has committed to installing acid plants that have an acid conversion efficiency of 99.85% or greater. This will result in a total SO_2 emission rate that is equivalent to that used in the EIS, namely 152 g/s of SO_2. The SO_2 production per tonne of acid is reduced to 0.975 kg/ t acid with the increased acid conversion efficiency.

The increased production of sulphuric acid also has implications for the release of sulphuric acid mist from the acid plant stacks. Revised emission estimates were based on the assumed production rate of 0.075 kg H_2SO_4 / t of 100% acid. Revised stack parameters for the sulphuric acid plant are presented in Table G-1 below.

Table G-1 Revised source parameters for air emissions from Sulphuric Acid Plant, Stage 2

Source name	No. stacks, Stage 2	Stack height m	Stack diameter m	Stack exit velocity m/s	Stack exit temp °C	SO_2 emission rate per stack, g/s	Sulphuric acid mist emission rate per stack, g/s
Sulphuric Acid Plant	4	60	2.67	15	82	38	2.5

The additional sulphuric acid requirements on site will also require the import of more solid sulphur pastille. The dust implications due to the materials handling aspects have been addressed in Section G.3 below.

G.2.2 Revised modelling results for SO_2 and sulphuric acid

Revised modelling results for SO_2 and sulphuric acid are presented in Table G-2. Results for SO_2 are presented as cumulative impacts with other industrial sources, while sulphuric acid emissions from the Refinery in isolation are presented. These show that predicted impacts are below the air quality guidelines for both pollutants at residential locations. The predictions are close to the results presented in the EIS.

Revised figures showing the air quality impacts for SO_2 due to the Refinery and background industrial sources are presented in Figures G1 to G3 for 10-minute, 1 hour and 24 hour averaging times respectively. These figures present essentially the same region of impact as the figures that were presented in the EIS, despite the increased requirement for acid production. The predicted 24-hour average concentration of SO_2 shows that this may exceed the EPA's air quality guideline to the west of the site, however based on the modelled results from existing sources in Gladstone, this region also experiences a significant contribution of impacts from the Gladstone Power Station.

The revised figure showing the 3-minute average concentration of sulphuric acid mist due to the refinery in isolation is presented in Figure G9. The figure shows the predicted ground-level concentration is below the guideline level, with the exception of a small region to the south of the refinery. This region is not a residential or future residential location and is within the Gladstone State Development Area, thus adverse health impacts would not be expected at this location.

Table G-2 Modelled ground-level concentrations of SO_2 and Sulphuric Acid due to the Refinery (Stage 2) and background industrial sources (µg/m³)

Pollutant	Averaging time	Clinton area	Yarwun Area	Rural-residential	EPA Monitoring sites	EPP (Air) Guideline
Sulphur dioxide	10 minute 99.9th	618	349	497	473	700
	1 hour 99.9th	432	244	347	330	570
	24 hour	97	65	85	85	100
	Annual	12	17	17	14	60
Sulphuric acid (Refinery in isolation)	3 minute	4	9	10	11	33, Vic SEPP

G.2.3 Aviation safety

The aviation safety implications of the additional sulphuric acid plant stack have been evaluated. The assessment was conducted using the methodology adopted for the EIS and is compliant with the Civil

Aviation Safety Authority (CASA) requirements, as set out in their Advisory Circular AC 139-05(0) "*Guidelines for conducting plume rise assessments*", 2004.

The aviation safety assessment in the EIS demonstrated that the site complied with CASA regulations and that the modelled plume rise was below the Obstacle Limitation Surface (OLS) that was applicable at the site location. The worst-case results were apparent in year 2004.

The assessment has shown that the addition of a fourth sulphuric acid stack has resulted in no change to the conclusions of the aviation safety assessment. This is due to the separation of the sulphuric acid plant stacks on site, which is sufficient such that the plumes from each stack do not merge before the vertical velocity falls below the threshold vertical velocity. The site remains compliant with the CASA requirements for aviation safety.

G.3 Revisions to dust impacts from materials handling

G.3.1 Rail receival of ore

The EIS was based on the transport of ore sourced locally from Marlborough to site using a slurry pipeline. The Supplementary Report has included details of the transport of ore from Marlborough to the refinery by rail, replacing the need for the slurry pipeline. The dust implications of the rail receival of the ore have been assessed in revised modelling for the site.

Updated site data from GPN indicated that the rail unloading would employ a rotary dumper, with the ore subsequently recovered from the underground receival bin. The rail receival area is to be semi-enclosed to control dust.

The local ore is reported to be received at site with a moisture content of 18%, classifying it as a wet ore. Additional water sprays will be used at transfer points as necessary to reduce dust.

The locations of local ore conveyors and stockpile have been included in modelling of particulate matter from the site. Revised emission rates of particulate matter from all sources are presented in Section G.3.4.

G.3.2 Export of amsul through Barney Point

GPN has advised that the construction of the new berth at Fisherman's Landing wharf that was to be used for the export of crystalline ammonium sulphate (amsul) is now uncertain due to the cessation of other projects that were to use the new berth. The proposed route for export of amsul is now through Barney Point wharf, to the east of the site.

Handling of amsul at Barney Point will be carried out in the same manner as that proposed at Fisherman's Landing. The amsul will be trucked to the wharf and unloaded to a covered dump station before being transported on a covered conveyor to the enclosed amsul storage shed. The amsul will be loaded onto conveyors inside the shed, and covered conveyors will be used to transport the amsul to the ship.

G.3.3 Increased sulphur imports

The increased requirements for sulphuric acid on site will also require the importation of additional solid sulphur pastille. An estimated 1.6 Mt/y of sulphur will be required for Stage 2 operations.

Control factors were applied to materials handling emissions in the EIS to represent the nature of the material being handled. As explained in the EIS, sulphur is delivered to the site as a low dust-generating pastille material, with the pastille size typically between 2 and 4 mm in diameter. During the pastille formation process, the sulphur is coated in a dust suppressant medium to further reduce the possibility of dust generation. The pastille is also robust and resistant to breakage, thus minimising the formation of fine particles during handling.

GPN has committed to the use of dust suppressant sprays on the sulphur handling facility. This will comprise a combination of water sprays, and the use of proprietary dust suppression chemicals that have demonstrated effectiveness for sulphur handling. Dust suppression sprays will be installed at each conveyor transfer point, and during stockpiling of the sulphur. Portable water sprays will be used in the front end loader operating areas to control dust during handling.

A control factor of 90% has been adopted for sulphur pastille to acknowledge the small potential for some dust from this raw material, despite the inherently stable properties of the material. This factor was selected from the NPI emissions handbook for mining, using the factor for miscellaneous transfer and conveying activities, as the most representative of the available control efficiencies in the handbook. The binding medium that coats the pastille and use of dust suppression sprays with chemical dust suppression for handling points are effective at controlling dust emissions from sulphur.

The dust implications associated with this increase in sulphur handling have been incorporated into new modelling of dust from materials handling operations on site.

G.3.4 Revised emission rates for particulate matter

Revised emission rates for all sources of particulate matter from refinery operations are summarised below. The dust emissions from all stockpile sources have increased since the EIS due to the inclusion of a front-end loader that is operational on each stockpile to recover the material. These emission rates have been used in revised modelling of dust emissions from the site. Emissions from the RSF area remain unchanged from the EIS and have been included in the modelled sources of dust.

Table G-3 Revised emission rate of TSP and PM_{10} from materials handling operations, Stage 2

Source	Type of material	Emission rate, Stage 2 (g/s)		Control factors used
		TSP	PM_{10}	
Ship unloader and conveyor [1]	Sulphur	0.38	0.15	90% - Water spray with chemicals (to represent coated pastille material)
	Imported Ore	0.46	0.19	90% - Covered conveyor, water sprays
Train unloader and conveyor	Local Ore	0.18	0.07	70% - Enclosure
Stockpile	Sulphur	1.11	0.45	90% - Water spray with chemicals (to represent coated pastille material)
	Imported Ore	1.36	0.55	90% - Water spray with chemicals (for wet ore)
	Local Ore	0.41	0.17	50% - Water spray
Conveyor to process plant	Sulphur	0.03	0.01	90% - Water spray with chemicals (to represent coated pastille material)
	Imported Ore	0.16	0.06	90% - Covered conveyor, water sprays
	Local Ore	0.05	0.02	90% - Covered conveyor, water sprays
Amsul loading to truck (on site)	Ammonium sulphate	0.03	0.01	70% - Enclosure
Amsul conveyor and loading to	Ammonium	0.95	0.38	70% - Covered conveyor

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[1] Wharf and conveyor facilities are shared between the sulphur and imported ore shipments, hence modelling has addressed the highest emission rates due to these two materials.

Source	Type of material	Emission rate, Stage 2 (g/s)		Control factors used
		TSP	PM_{10}	
ship (Barney Point)	sulphate			
Total emissions from site (g/s)		**1.97**	**0.80**	
Total emissions per year (t/yr) [2]		**46.9**	**18.9**	

G.3.5 Revised modelling results for dust

Revised predictions of dust concentrations due to operation of the refinery are presented in Table G-4. These results demonstrate that the off-site impacts due to materials handling operations are low, with the total impacts being dominated by background sources of dust.

Figure G4 presents the revised annual average results for TSP, including a constant background concentration. Figures G5 and G6 present the revised modelling results for PM_{10} for 24 hour and annual averages respectively. The results for particulate matter show that the impacts from the Refinery are small when compared to the assumed background concentrations of TSP and PM_{10} from other industrial, residential and biogenic sources in the region. Dust impacts are thus adequately managed by the control measures that are to be implemented on site.

Table G-4 Modelled ground-level concentrations (µg/m³) of TSP and PM_{10} with a constant background concentration[3] and deposition rate (g/m²/month) of TSP in isolation due to the Refinery (Stage 2)

Pollutant	Averaging time	Clinton area	Yarwun Area	Rural-residential	EPA Monitoring sites	Guideline
TSP	Annual	23.2	23.5	23.7	23.9	90
PM_{10}	24 hour	95.1	96.1	99.1	100.0	150
	Annual	23.1	23.3	23.4	23.5	50
Dust deposition (in isolation)	Monthly	0.02	0.03	0.05	0.05	4 g/m²/month

Since dust emissions from the RSF were unchanged from the EIS modelling, revised results have not been presented for the rural communities near the RSF.

G.4 Revisions to Hydrogen Sulphide and Odour emissions

G.4.6 Revised emission rates for Hydrogen sulphide

The hydrogen sulphide emissions from the neutralisation process are a by-product of the neutralisation reaction between the acid and limestone. The use of each of these reagents has increased, resulting in more H_2S generated from the refinery. To counter-act potential odour issues from the plant due to H_2S

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[2] Accounting for 91% availability of the plant, and the number of shipments for sulphur, imported ore and local ore per year

[3] Background concentration is estimated to be 93 µg/m³ for 24-hour average concentrations, and 23 µg/m³ for annual average concentrations

emissions, GPN has committed to reducing H_2S emissions from the neutralisation vent to below 0.01 g/s per stack. Other sources of H_2S and their respective emission rates are the cobalt dryer (0.003 g/s per stack) and the nickel dryer (0.00002 g/s per stack). All sources of H_2S have been included in revised modelling of H_2S impacts for the supplementary report.

G.4.7 Revised emission rates for Odour

Odour emissions have been estimated from the emissions of H_2S, SO_2 and NO_x (as NO_2 and NO). These pollutants have known odour thresholds, or ambient concentration at which they can be detected. The odour thresholds of each compound (Ruth, J.H., *Odour thresholds and irritation levels of several chemical substances: A review,* Am. Ind. Hyg. Assoc. J. (47), March 1986) were used to calculate an approximate odour emission rate from the Refinery, with units of OU/s.

Odour emissions for each source modelled are summarised in Table G-5 below. Oxides of nitrogen (NO_x) have been assumed to comprise 10% NO_2 and 90% NO for the purposes of this calculation.

Table G-5 Emission rate of odour from Refinery sources (Stage 2)

Source Name	Total odour emission rate from source (OU/s)
Sulphuric Acid Plant	125,000
H_2S Incinerator	1,540
Power Plant	34,380
H_2 Plant	12,330
Neutralisation Vent	26,320
Cobalt dryer vent gas	7,430
Nickel powder dryer off-gas	60
Total odour emission from site (OU/s)	**207,060**

Odour guidelines that are applicable in Queensland are specified by the Queensland EPA. For ground-level sources and down-washed plumes from short stacks, the relevant odour criterion that is applicable at the most exposed existing or likely future off-site sensitive receptor location is 2.5 OU, based on a 1-hour average, 99.5th percentile. The odour emission points at the refinery are wake-affected point sources.

G.4.8 Revised modelling results for H_2S and Odour

Predicted impacts of H_2S and odour at residential locations near the refinery are summarised in Table G-6 below. These results demonstrate that predicted impacts at residential locations are well below the relevant guidelines.

Table G-6 Modelled ground-level concentrations of hydrogen sulphide (µg/m³) and odour (OU) due to the Refinery in isolation (Stage 2)

Pollutant	Averaging time	Clinton area	Yarwun Area	Rural-residential	EPA Monitoring sites	Guideline
H_2S	30 min 99.9th	0.06	0.18	0.19	0.26	7
	24 hour	0.01	0.03	0.04	0.06	150
Odour	1 hour, 99.5th percentile	0.04	0.16	0.15	0.19	2.5 OU

Figures showing the contours for hydrogen sulphide (30 minute and 24 hour averages) are presented in Figures G7 and G8 respectively for the refinery in isolation. These figures show that the predicted ambient concentrations of H_2S are well below the relevant guideline levels at all locations on the modelling grid. Thus, health impacts and odour nuisance effects due to H_2S are not expected to occur.

Predicted odour impacts due to the refinery operation are shown in Figure G13. These impacts are demonstrated to be low at all locations off-site, and well below the EPA's guideline levels for odour. No odour nuisance impacts would be anticipated from the refinery.

G.5 Revisions to Greenhouse Gas Assessment

Increases in the amount of sulphuric acid produced on site and the requirements for limestone consumption have required a revision to the greenhouse gas assessment for the project.

The excess heat generated during the sulphuric acid production process is used to generate power for use on the refinery site and to generate high pressure steam which is used for process heating. The increased acid production, from 3.3 Mt/y to 4.5 Mt/y, has resulted in a revised estimate of 169 MW of power generated on site for Stage 2, which has increased from 75 MW that was assumed in the EIS. The increased power generation is used on site and will result in less power purchased from the grid (7 MW, down from 47 MW in the EIS). There will also be increased requirement for on-site power generation using natural gas (consumption rate of 820 GJ/hr, up from 143 GJ/hr).

The requirements for limestone to neutralise the acidic waste streams from the refining process have also increased from the EIS. Limestone use will be increased from 1.43 Mt/y reported in the EIS to 2.6 Mt/y. This change is reflected in the revised emission rates from various refinery processes.

Table G-7 shows the energy consumption inputs to the project's greenhouse gas emissions inventory.

Table G-7 Inputs for energy consumption for Greenhouse Gas assessment, Stage 2

Parameter	Stage 2	Units
Electricity– process generated	1,349,000	MWh/year
Electricity – from grid	56,000	MWh/year
Natural Gas consumption – power generation and process use	6,649	TJ/year
LPG – transport	260	kL/year
Diesel – transport and emergency power	1,930	kL/year
Hours of operation of refinery	8,040	hours per year

Greenhouse gas emissions are categorised according to where the actual greenhouse gas release occurs. Scope 1 emissions occur on-site, for example due to direct fuel combustion. Scope 2 emissions are due to the use of purchased electricity, with emissions occurring at the power station.

Table G-8 provides the greenhouse gas inventory for Stage 2 of the refinery operation. These results show that the greenhouse gas inventory for the project is dominated by the acid neutralisation reaction, which generates CO_2 as a by-product of the reaction, and by natural gas consumption for power generation and process use. Stage 2 of the project is forecast to release up to 1.4 Mtpa CO_2-e.

Table G-8 Greenhouse Gas Inventory, Stage 2

Emission Scope	Parameter	Value	Units	Emission Factor	EF Units	t CO_2-e emitted per year	Note
2 - Off Site	Electricity – from grid	56,000	MWh/year	0.903	kg CO_2-e / kWh	50,600	1
1 - On Site	Natural Gas consumption – power generation and process use	6,649	TJ/year	52.6	kg CO_2-e / GJ	349,800	2
1 - On Site	LPG – transport	260	kL/year	1.6	t CO_2-e / kL	450	3
1 - On Site	Diesel – transport, emergency power	1,930	kL/year	2.7	t CO_2-e / kL	5,250	4
Process emissions							
1 - On Site	PAL Vent Scrubber Off-gas	12,200	t CO_2 / year	-	-	12,200	5
1 - On Site	Solution Neutralisation Vent Scrubber Offgas	985,850	t CO_2 / year	-	-	985,850	5
				Total t CO_2-e		1,404,150	
				Total Mt CO_2-e		1.40	

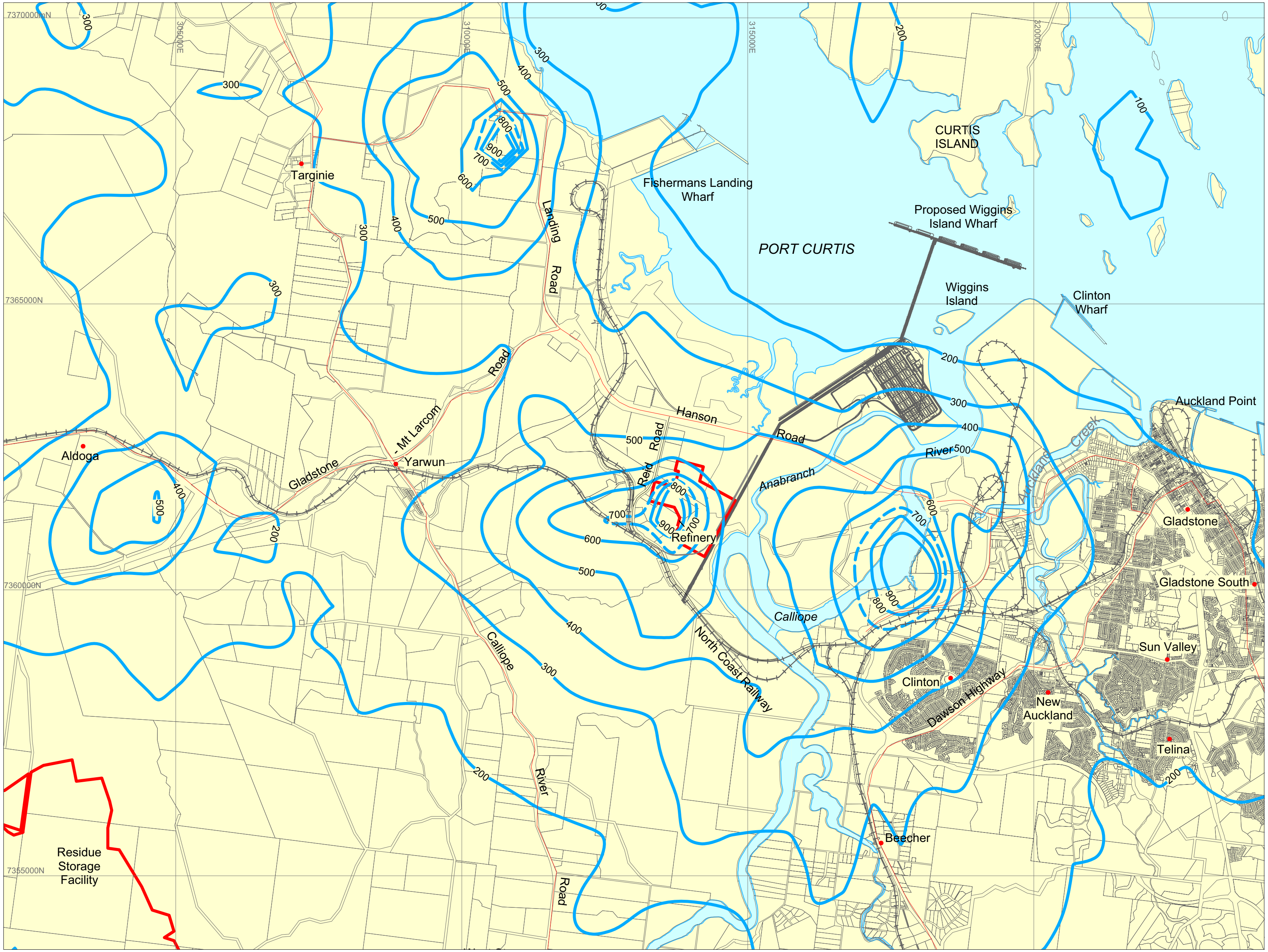
Note:		
	1	Table 5, Column A (Qld) AGO Factors and Methods Workbook (December 2006)
	2	Table 2, Scope 1 (Qld) AGO Factors and Methods Workbook (December 2006)
	3	Table 3, Column C, LPG, AGO Factors and Methods Workbook (December 2006)
	4	Table 3, Column C, Industrial Diesel Fuel, AGO Factors and Methods Workbook (December 2006)
	5	Gladstone Pacific Nickel Limited quoted figure, from process simulation.

G.6 Additional contour figures

Additional contour figures for air pollutants that were modelled in the EIS have been included in the supplementary report for H_2S, sulphuric acid, nickel, cadmium, mercury and odour. These show the predicted impacts of pollutants at all locations on the modelling grid. Figures for SO_2, sulphuric acid, PM_{10}, TSP, hydrogen sulphide and odour have been discussed in the preceding sections of this appendix.

Predicted annual average concentrations of nickel, cadmium and mercury are presented in Figures G10 to G12. The impacts for cadmium and mercury are low at all locations on the grid when compared to air quality guidelines, indicating that adverse effects on human health are considered unlikely due to the operation of the refinery. Predicted concentrations of nickel show that the health-based guideline is exceeded over a small region to the south-west of the refinery. As noted in the EIS, emissions of nickel were modelled at the maximum emission limit for the purposes of the EIS. GPNL does not expect that nickel emissions would be as high as the in-stack concentration of 1 mg/Nm³ that was used in the EIS at any stage of the project operation. This will be confirmed by the annual stack testing that GPNL has committed to for the project.

Figures



0 1.25 2.5km

Scale 1:100,000 (A4)

MGA Z56, GDA94

200 SO₂ Concentration Contours (µg/m³)

700 Air Quality Guideline

URS

Client
Gladstone Pacific Nickel Ltd

Project
GLADSTONE NICKEL PROJECT
ENVIRONMENTAL IMPACT STATEMENT
SUPPLEMENT
AIR AND GREENHOUSE GAS ASSESSMENT

Drawn: VH
Approved: CMP
Date: 27-11-2007
Job No: 4262 5791
File No: 42625791-g-257.wor

Title
99.9th PERCENTILE 10 MINUTE AVERAGE CONCENTRATION OF SO_2 DUE TO REFINERY (Stage 2) WITH BACKGROUND INDUSTRIAL SOURCES (µg/m³)

Figure: G1
Rev: A
A4

Client

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Project

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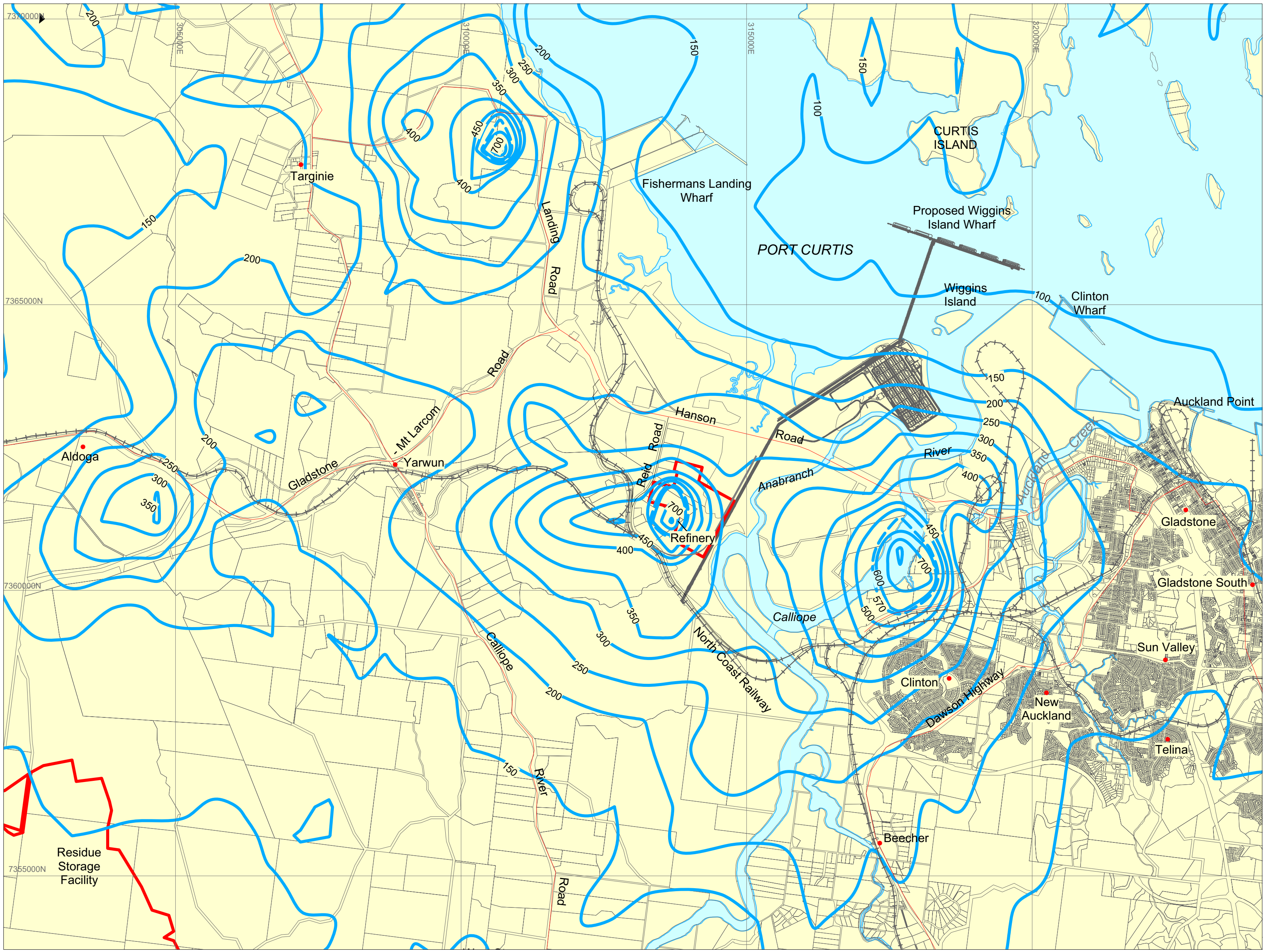
File No: 42625791-g-258.wor

Title

99.9th PERCENTILE 1 HR AVERAGE CONCENTRATION OF SO_2 DUE TO REFINERY (Stage 2) WITH BACKGROUND INDUSTRIAL SOURCES (μg/m³)

Figure: **G2**
Rev: A
A4



0 1.25 2.5km
Scale 1:100,000 (A4)
MGA Z56, GDA94

—200—	SO_2 Concentration Contours (μg/m³)
- -570- -	Air Quality Guideline

Client

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ENVIRONMENTAL IMPACT STATEMENT
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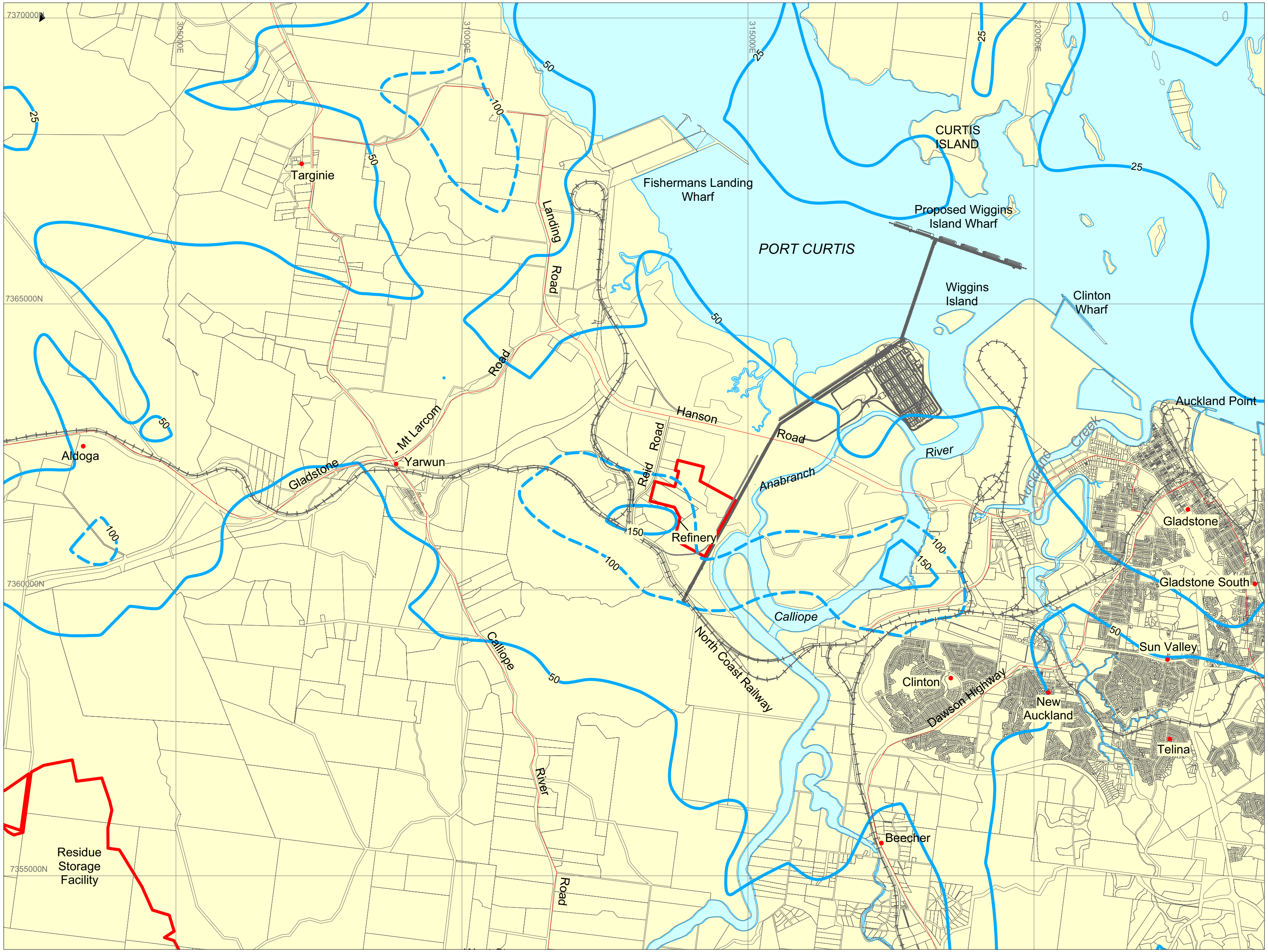
Title

MAXIMUM 24 HOUR AVERAGE CONCENTRATION OF SO_2 DUE TO REFINERY (Stage 2) WITH BACKGROUND INDUSTRIAL SOURCES (µg/m³)

Figure: **G3**
Rev: A
A4



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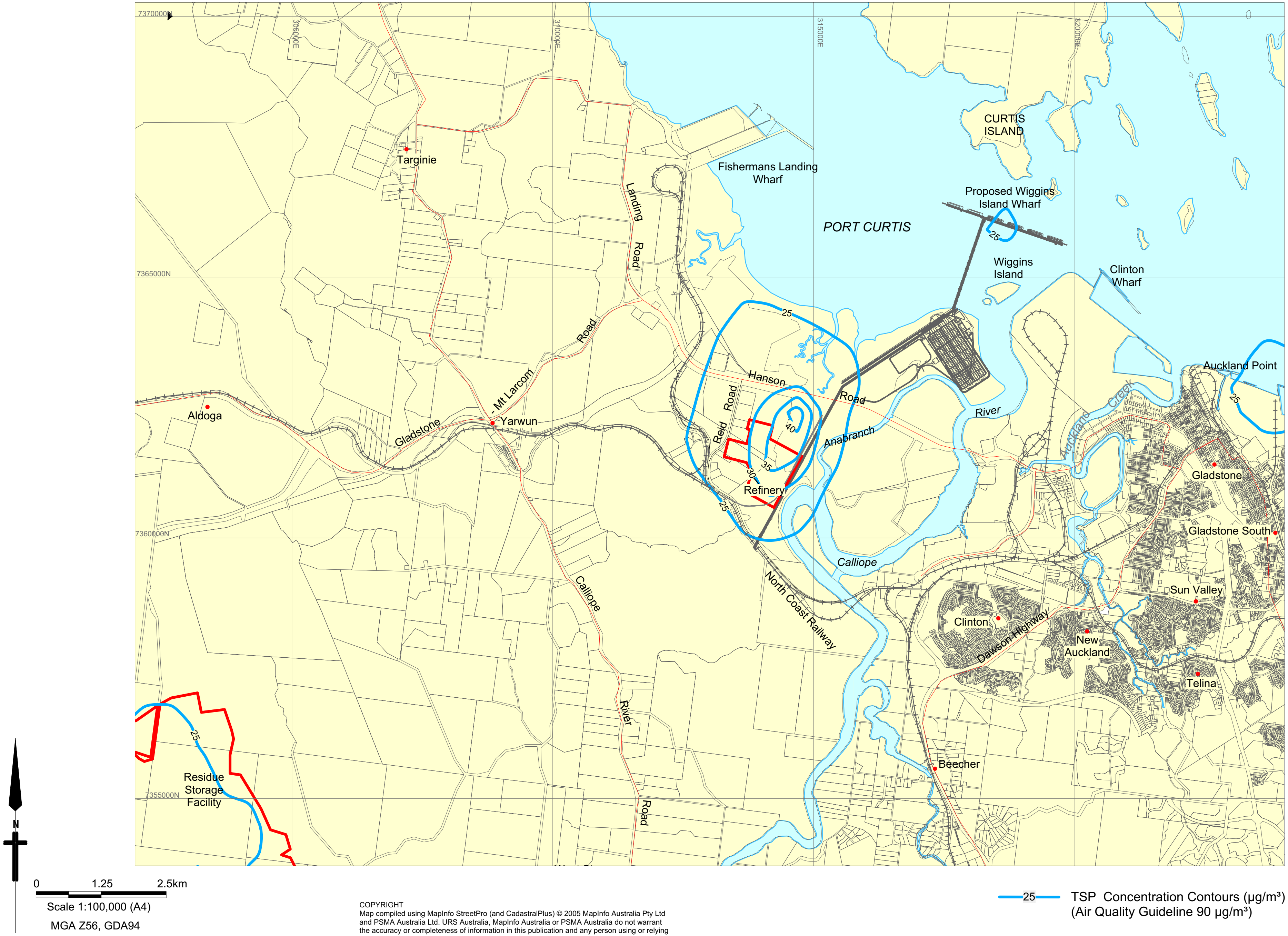
Title

ANNUAL AVERAGE CONCENTRATION OF TSP DUE TO REFINERY & MATERIALS HANDLING WITH CONSTANT BACKGROUND CONCENTRATION (Stage 2) (µg/m³)

Figure: **G4**
Rev: A
A4



TSP Concentration Contours (µg/m³)
(Air Quality Guideline 90 µg/m³)

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Project

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ENVIRONMENTAL IMPACT STATEMENT
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Title

MAXIMUM 24 HOUR AVERAGE CONCENTRATION OF PM_{10} DUE TO REFINERY AND MATERIALS HANDLING (Stage 2) AND CONSTANT BACKGROUND CONCENTRATION (µg/m³)

Figure: **G5**
Rev: A
A4

N

0 1.25 2.5km
Scale 1:100,000 (A4)
MGA Z56, GDA94

95 PM_{10} Concentration Contours (µg/m³)
(Air Quality Guideline 150 µg/m³)