Appendix G

Air quality assessment

Report

AGL Barker Inlet Power Station Air Quality Impact Assessment

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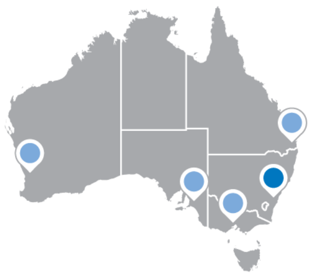

Adelaide

5 Peel Street,
Adelaide SA 5000
Ph: +61 8 8332 0960
Fax: +61 7 3844 5858

Brisbane

Level 19, 240 Queen Street
Brisbane Qld 4000
Ph: +61 7 3004 6400
Fax: +61 7 3844 5858

Melbourne

Level 6, 99 King Street
Melbourne Vic 3000
Ph: +61 3 9111 0021
Fax: +61 2 9870 0999

Perth

Level 1, Suite 3
34 Queen Street, Perth WA 6000
Ph: +61 8 9481 4961
Fax: +61 2 9870 0999

Sydney Head Office

Suite 1, Level 1, 146 Arthur Street
North Sydney, NSW 2060
Ph: +61 2 9870 0900
Fax: +61 2 9870 0999

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Executive summary

Pacific Environment was commissioned by Coffey Services Australia P/L (Coffey) to undertake an Air Quality Impact Assessment (AQIA) for a proposed power station expansion (the Project) adjacent to AGL's Torrens Island facility in South Australia.

AGL propose to expand the existing power station on Torrens Island, located in the southwestern portion of the island and about 15 km northwest of the central business district of metropolitan Adelaide. The expansion is referred to as the Barker Inlet Power Station (BIPS) and it will be located adjacent to AGL's existing Torrens Island Power Station (TIPS).

A review of proposed generation technology identified key air pollutants, as well as relevant emission controls, which as proposed, include Selective Catalytic Reduction (SCR) of NO_x emissions, use of low sulphur fuels (as relevant to sulphur dioxide and sulphate particulate), as well as combustion controls for the minimisation of primary NOx and CO emissions.

Emissions from the Project were quantified based on a combination of manufacturer data, fuel specifications, and industry references, including the US EPA AP-42 emission factor database. These emission estimates were applied in dispersion modelling, which was undertaken using the CALPUFF dispersion modelling package with a site specific CALMET meteorological dataset. CALMET was run in a nested configuration for the year 2009, based on surface observations from a total of 21 Bureau of Meteorology automatic weather stations, in conjunction with upper air meteorological data, sourced from Adelaide airport.

Dispersion modelling was conducted for key pollutants, and for a range of operational and cumulative scenarios. Results were then assessed against regulatory criteria. For NO_2, CO, PM_{10} and $PM_{2.5}$, cumulative impacts were assessed as the sum of:

- Existing ambient background levels as measured by SA EPA ambient air quality modelling sources.
- Dispersion modelling of emissions the existing TIPS B power station.
- Dispersion modelling of emissions from the Project.

Nitrogen dioxide concentrations were based on the Ozone Limiting Method, in conjunction with hourly-varying ozone and NO_2 data sourced from the SA EPA Netley monitoring station. CO, SO_2 and PM_{10} have incorporated 70^{th} percentile background concentrations.

Hazardous air pollutants, including formaldehyde, benzene and PAHs were assessed against SA EPA impact assessment criteria on an incremental basis.

The assessment incorporated several elements of conservatism that should be acknowledged when considering the assessment predictions:

- Power generation emissions were assumed to occur on a continuous basis for all 8,760 hours of the annual modelling period. This provides a conservative assessment of peaking and network support operations, which are intermittent in nature. This conservatism is most pronounced in results for averaging periods beyond 1 hour in duration (e.g. $PM_{2.5}$ 24 hour and annual averages), where it is unlikely that peak operations would occur on an extended basis.
- Enhancement of plume rise via plume merging effects was ignored. A review of stack proximity identified that in practice, plumes from neighbouring stacks will merge and

experience enhanced plume rise, with an anticipated reduction in ground level concentrations.

- Netley monitoring data was applied across the modelling domain. A review of temporal and spatial variability identified these data as being a conservative representation of air quality across the Adelaide region.

When assessed against regulatory criteria, all predictions were found to be within SA EPA impact assessment criteria with the exception of annual average $PM_{2.5}$, for which the background was estimated to be exceeding the annual criterion. Noting this, the scale of peak annual predictions (0.3 µg/m^3), when considered in conjunction with conservative assumptions around operating frequency, implies that the likelihood of the Project resulting in a measurable contribution to cumulative $PM_{2.5}$ concentrations is minor.

Accordingly, based on the analysis documented within this assessment, the potential for the Project to result in adverse air quality impacts is considered minor.

Table of contents

List of Figures

List of Tables

1 Introduction

Pacific Environment has been commissioned by Coffey Services Australia P/L (Coffey) to undertake an Air Quality Impact Assessment (AQIA) for a proposed power station expansion (the Project) at Torrens Island in South Australia.

AGL propose to expand the existing power station on Torrens Island, located in the southwestern portion of the island and about 15 km northwest of the central business district of metropolitan Adelaide. The expansion is referred to as the Barker Inlet Power Station (BIPS) and it will be located adjacent to AGL's existing Torrens Island Power Station (TIPS).

In 2009, AGL received approval for an expansion of power generation on Torrens Island, which has not been progressed to date. The primary proposed change to the approved development is to use reciprocating engines rather than heavy duty gas turbines as previously proposed.

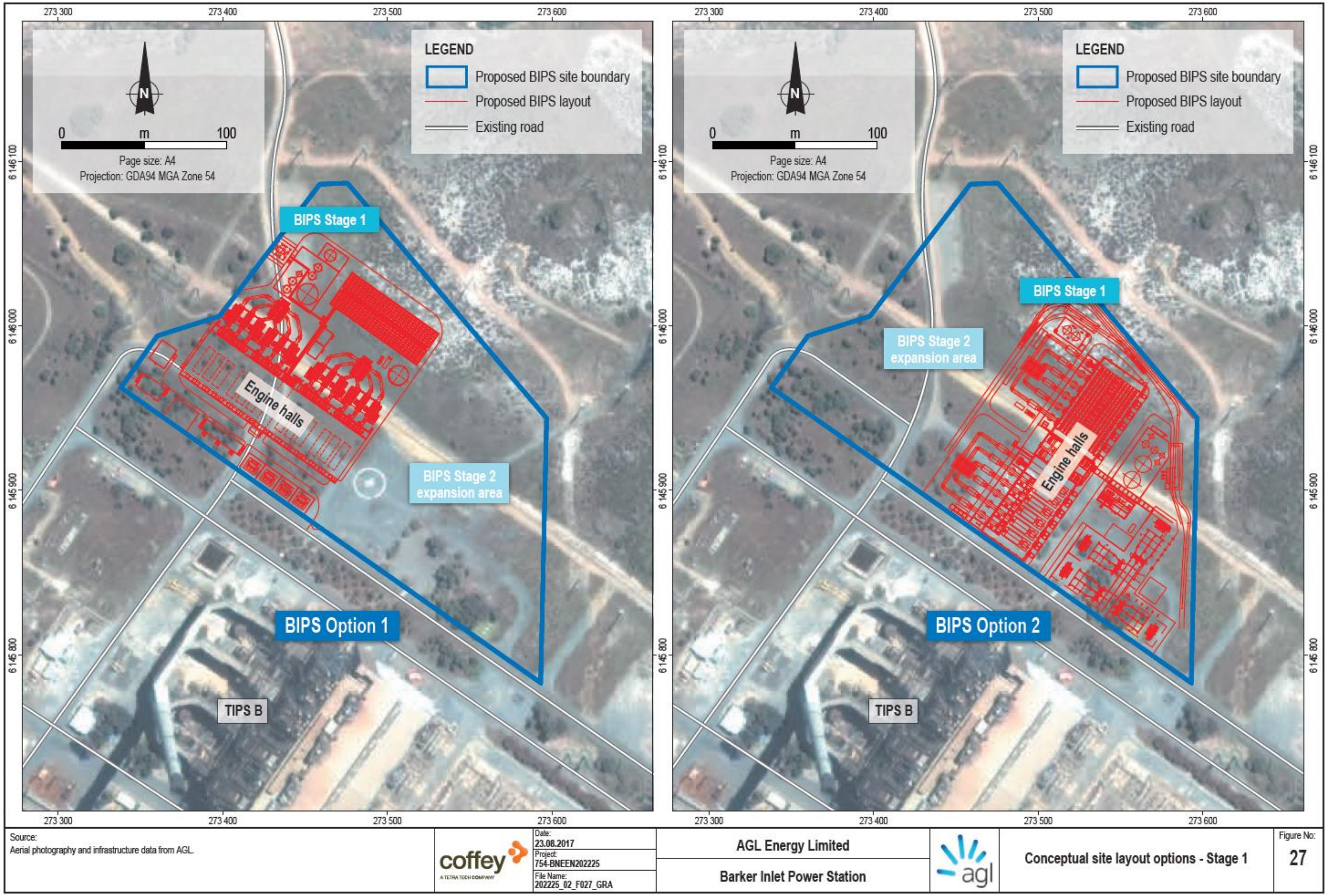
The Project is proposed to be constructed in two separate stages (hereafter referred to as 'Stage 1' and 'Stage 2'). There are two conceptual options for the BIPS Stage 1 layout as shown in Figure 1-1. Stage 2 will essentially be the mirror image of Stage 1 and the general area is indicated on the figure. The layouts provided are conceptual and will be refined during the detailed design phase. The development will however remain within the proposed project area.

This AQIA provides an assessment of the potential air quality impacts associated with operation of the Project. Specifically, this work includes:

- A review of the Project design and associated air emissions.
- A review of the existing environment, and the legislative framework for air quality management.
- Quantification of Project emissions.
- Atmospheric dispersion modelling of Project emissions, with assessment of model predictions against regulatory criteria.

Detail of the methodology and findings of this work is provided within this document.

Figure 1-1: Aerial image showing BIPS conceptual site layout options relative the existing TIPS B power station



2 Project description

2.1 Overview

The Project involves the expansion of existing operations to support growth in peak electricity demand, whilst also providing a more reliable supply of energy to SA customers. To do this, AGL proposes to develop up to 420 MW of additional peaking generation capacity over a two stage development process.

As part of Stage 1, the revised configuration will initially have 12 reciprocating engines capable of producing 210 MW of electricity, with a Stage 2 expansion of an additional 12 engines producing a further 210 MW of electricity.

The new configuration would also have the option of diesel fuel firing, which would be implemented if the market conditions are more suitable, or if emergency conditions arise during a time at which the natural gas supply is interrupted.

The new plant configuration occupies a land area equivalent to the currently approved footprint. Further optimisation of the layout has resulted in the footprint being moved slightly closer to the existing power station but still within the currently approved project area (as per Figure 1-1).

2.2 Generation technology

The proposed reciprocating engines were originally developed for marine applications, primarily LNG ships engines using readily available natural gas as fuel. These engines are currently used for power generation projects across the world. Their typical power generation application is in relatively weak electricity grids, including large mines, and in support of variable generation sources such as wind farms.

The engine type is fuel versatile, and can be run on low pressure natural gas or liquid fuel. In the gas mode, the engine is operated according to the lean-burn principle, where there is about twice as much air in the cylinder compared to the minimum needed for complete combustion of gas. This allows a controlled combustion and a high specific cylinder output without immediate risk of knocking or self-ignition when the process is well controlled. Oxides of Nitrogen (NO_x) emissions are also reduced, as the pre-dilution of the combustion air results in lower peak combustion temperatures.

In gas engines, the compression of the air/gas mixture with the piston does not heat the gas enough to start the combustion process. A liquid fuel such as diesel oil has a lower self-ignition temperature than gas and the heat in the cylinder close to the top position is enough to ignite the liquid fuel which, in turn creates enough heat to cause the air/gas mixture to burn. The amount of pilot fuel typically ranges from 1 to 5% of the total fuel consumption at full load. The engine works according to the Diesel process in liquid fuel mode and Otto principle in gas mode. The burning mixture of fuel and air expands, which pushes the piston. Finally the products of combustion are removed from the cylinder, completing the cycle. The energy released from the combustion of fuel is transferred to the engine flywheel via the moving piston. An alternator is connected to the rotating engine flywheel and produces electricity (IPPC, 2006).

Consequently, many of their characteristics are different to the heavy-duty power station engines previously described in the original development application.

The key differences are:

- Multiple smaller units (18 MW) each operating as a single dispatchable power station.
- Smaller network capacity step changes when starting and stopping generation units.
- Faster start times (with lower associated energy consumption); nominally 5 minutes from stopped to full load.
- Higher thermal efficiency; uses 20-30% less fuel than gas turbines and so produces less greenhouse gases per unit of electricity generated.
- Reduced waste water production.
- Diesel fuel capability to allow alternative fuel when gas prices peak beyond diesel pricing, or when the gas supply is interrupted.

Changes in the gas supply market across Australia have led to increased gas prices and potentially constrained physical supply. To ensure operational flexibility, particularly at time of high demand, reciprocating engines capable of firing both natural gas and distillate are proposed. Natural gas will be the predominant fuel. Dual fuel engines have the ability to use a backup liquid fuel when gas supply is interrupted.

2.3 Emissions to Air

Reciprocating engines have the potential to produce air emissions of the following substances:

- Nitrogen oxides (NO_x), including nitrogen dioxide (NO_2).
- Sulphur dioxide (SO_2).
- Particulate matter (PM), both as:
  - Particulate Matter less than 2.5 micrometres in aerodynamic diameter ($PM_{2.5}$)
  - Particulate Matter less than 10 microns in aerodynamic diameter (PM_{10})
- Volatile Organic Compounds (VOCs) including benzene and formaldehyde.
- Polycyclic Aromatic Hydrocarbons (PAHs) including Benzo(a)Pyrene (BaP).

Project emissions will be controlled to be within the limits set out in the South Australian *Environment Protection (Air Quality) Policy 2016* (SA EPA, 2016a) by the installation of selective catalytic reduction (SCR) units to reduce NO_x emissions in the exhaust gases to acceptable levels.

NO_x emissions will be minimised using primary combustion controls (e.g. lean-burn, ignition timing) in conjunction with SCR, which involves the injection of ammonia or urea upstream of a catalyst, where NO_x emissions are primarily reduced to nitrogen and water. SCR will be used under both natural gas and diesel operation

When used, diesel fuel will consist of low sulphur automotive distillate of mineral origin that meets the specification of the *Fuel Standard (Automotive Diesel) Determination 2001* under the *Fuel Quality Standards Act 2000.* This fuel contains a sulphur content of equal to or less than 10 mg/kg.

The combustion products from operation will be discharge via 30 m high stack clusters, with one stack cluster for each set of six engines. This equates to two stack clusters for Stage 1 and an additional two clusters for Stage 2.

2.4 Staging of development

Stage 1 is planned to commence construction late 2017 or early 2018 with commercial operation in early 2019.

When Stage 1 is in commercial operation, the existing fuel oil firing capacity at TIPS will be de-commissioned. Liquid fuel operation capacity will be transferred from TIPS to BIPS. The TIPS heavy fuel oil firing will be replaced with those from the reciprocating engines operating with SCR during the rare times that liquid fuels are used. The use of SCR is expected to result in lower emissions than the current TIPS.

The timing of the Stage 2 of the project will be dependent on the mothballing plans currently being developed for the TIPS A Station which is expected to occur during the period 2019 to 2021.

3 Legislative Framework

Air quality is managed in South Australia by the application of a combination of the following criteria and standards:

- Air quality impact assessment criteria.
- Industrial source emission limits.
- Ambient air quality standards.

Assessment criteria and emission limits are prescribed in (SA EPA, 2016a) *South Australia Environment Protection (Air Quality) Policy 2016* ('the EPP Air'), which is in force under Section 28 of the Environment Protection Act 1993.

The Air EPP is applied with the overarching objective of ensuring that the national ambient air quality standards prescribed in (DoE, 2016) *National Environment Protection (Ambient Air Quality) Measure* ('NEPM AAQ') are achieved.

A summary of assessment criteria and emission limits relevant to the Project is provided in the following sections.

3.1 Impact assessment criteria

The air quality criteria applied in this assessment are presented as maximum concentrations in Schedule 2 of the Air EPP, as shown in Table 3-1.

Table 3-1: Summary of assessment criteria, EPP Air Schedule 2

Pollutant	Classification	Averaging Period	Maximum Concentration (µg/m^3)
Nitrogen dioxide	Toxicity	1 hour	250
		Annual	60
Carbon monoxide	Toxicity	1 hour	31,240
		8 hours	11,250
Sulphur dioxide	Toxicity	1 hour	570
		24 hours	230
		Annual	60
Particles as PM_{10}	Toxicity	24 hours	50
Particles as $PM_{2.5}$	Toxicity	24 hours	25
		Annual	8
Formaldehyde	Toxicity , Group 1 carcinogen (IARC)	3 minutes	44
Benzene	Group 1 carcinogen (IARC)	3 minutes	58
		Annual	10
PAHs	Group 1 carcinogen (IARC)	3 minutes	0.8
		Annual	0.003

3.2 Source emission limits

The Environment Protection Authority (EPA) regulates air emission sources in South Australia. Schedule 4 of the Air EPP provides generic emission limits that are considered in conjunction with air quality risks in the licencing process. Relevant emission limits are provided in Table 3-2.

Table 3-2: SA EPA EPP Schedule 4 - Stack emission limits

Pollutant	Applicability	Reference Conditions	Emission Limit (mg/m^3)
NO_2	Power generation of 250MW or greater	7% O_2	700
Particulate matter	Any activity other than heating metals or metal ores	For boilers / incinerators 12% CO_2	100
CO	Any activity	N/A	1,000

4 Existing ambient air quality

An understanding of existing ambient air quality is required to allow an estimate of total pollutant concentrations, for assessment against cumulative air quality impact assessment criteria.

The existing ambient air quality in the immediate vicinity of the proposed BIPS is likely to be reflective of industrial sources, as well as transport emissions relating to the operation of the port and nearby urban area. More broadly within the region, air quality is considered typical of coastal urban settings, with influences from transport, industrial and domestic emissions sources contributing to total background pollutant levels.

SA EPA undertake monitoring of ambient air quality at a range of locations in and around Adelaide. Figure 4-1 shows the location of SA EPA monitoring sites relative to the Project and populated areas.

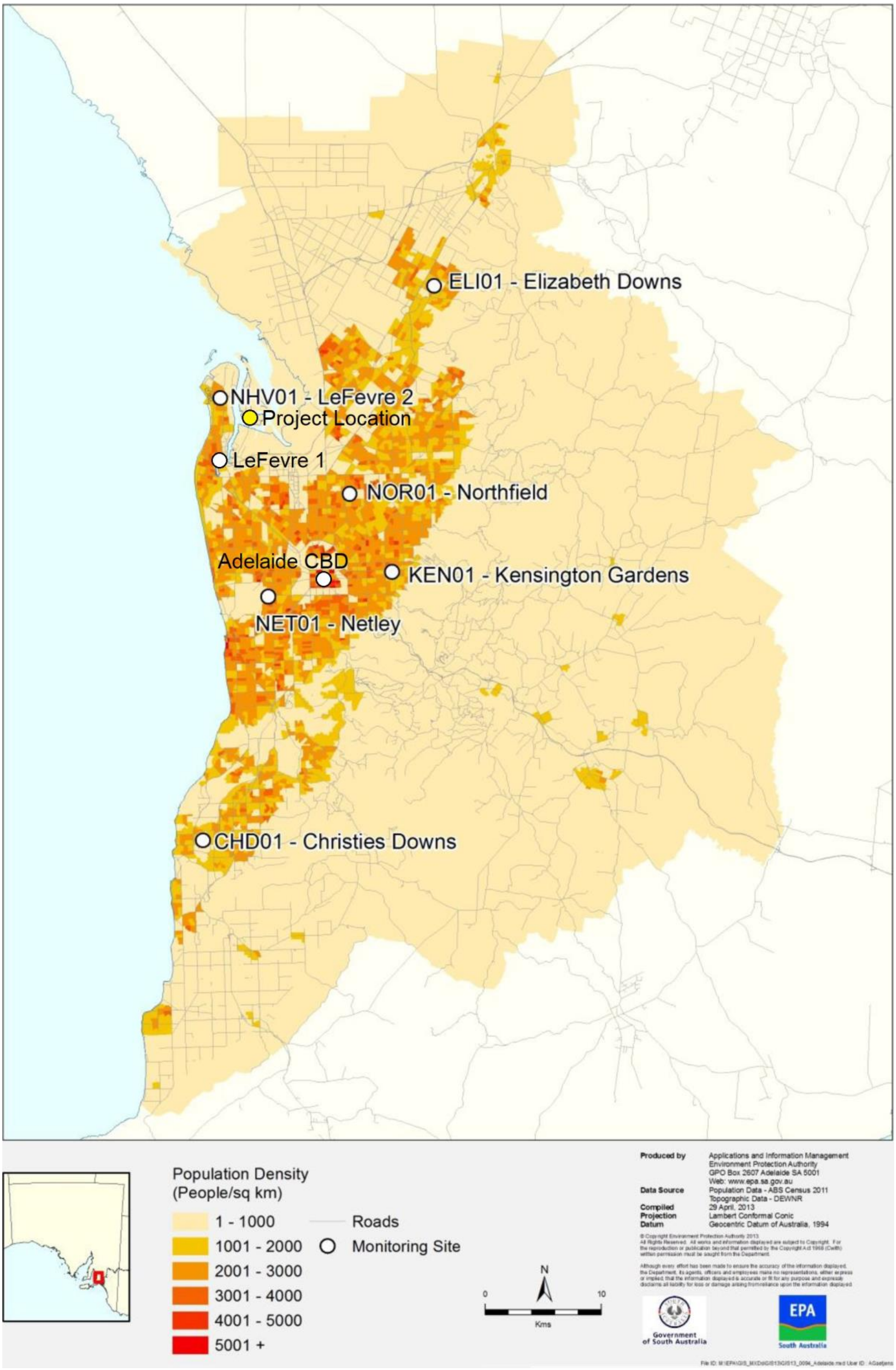


Figure 4-1: Location of SA EPA monitoring sites relative to the Project and populated areas

Source: Adapted from SA EPA (2014)

4.1 Selection of background monitoring data

SA EPA collect ambient air monitoring data at a range of locations around the Adelaide region. Discussions with SA EPA have identified 2009 as a suitable year for assessment of the Project.

Given the buoyant nature of emissions from thermal power generation, peak impacts have the potential to occur at areas of some distance from the source (e.g. 5 - 10 km), within an extent of Adelaide that includes several ambient air monitoring stations. Within this assessment, background concentrations have been incorporated based on a single station location. Noting the preference for conservatism in air quality assessment, a review of NO_2 trends has been undertaken in order to qualify temporal and spatial variability in pollutant levels, and ultimately, identify a monitoring location suitable for incorporation into the assessment. NO_2 has been adopted for this analysis on the basis that it is considered both the key pollutant for this assessment, and a surrogate for combustion pollutants in general.

Figure 4-2 presents long term trends in annual NO_2 concentrations, as sourced from SA EPA (2014) *Air Monitoring Report for South Australia 2013, Compliance with the National Environment Protection (Ambient Air Quality) Measure* as well as monthly SA EPA monitoring datasets for the years 2014 to 2016[1]. These trends are presented for the following statistics:

- 1 hour maximum
- 99th percentile daily maximum
- 50th percentile daily maximum.

The following attributes are evident in these data:

- Background NO_2 concentrations are highest at the Netley monitoring station, which reported the highest annual results across 38 of the 39 percentile/year combinations presented in Figure 4-2. This is consistent with the siting of the monitoring station in an area of heavy traffic (SA EPA, 2014).
- Across the years, there is a progressive downward trend in measured concentrations at all locations and all percentiles.

On this basis, Netley has been adopted as the source of NO_2, $PM_{2.5}$, Ozone and PM_{10} data. SO_2 and CO monitoring locations have been sourced from Northfield and Elizabeth Downs (respectively), on the basis that these are the only available stations for the year 2009. It is noted that the sensitivity of this assessment to these datasets is lower, given the minor scale of SO_2 and CO emissions.

It is also noted that the Le Fevre 1 monitoring location (labelled NHV01 in Figure 4-1) was established in March 2013, and hence does not possess monitoring records consistent with the modelling year. Whilst this station is located closer to the Project than Netley, the lower concentrations at this location mean that it would not provide a conservative representation of background air quality across the modelling domain.

[1] Source: SAGDD (2017): https://data.sa.gov.au/ (accessed 30/08/2017)

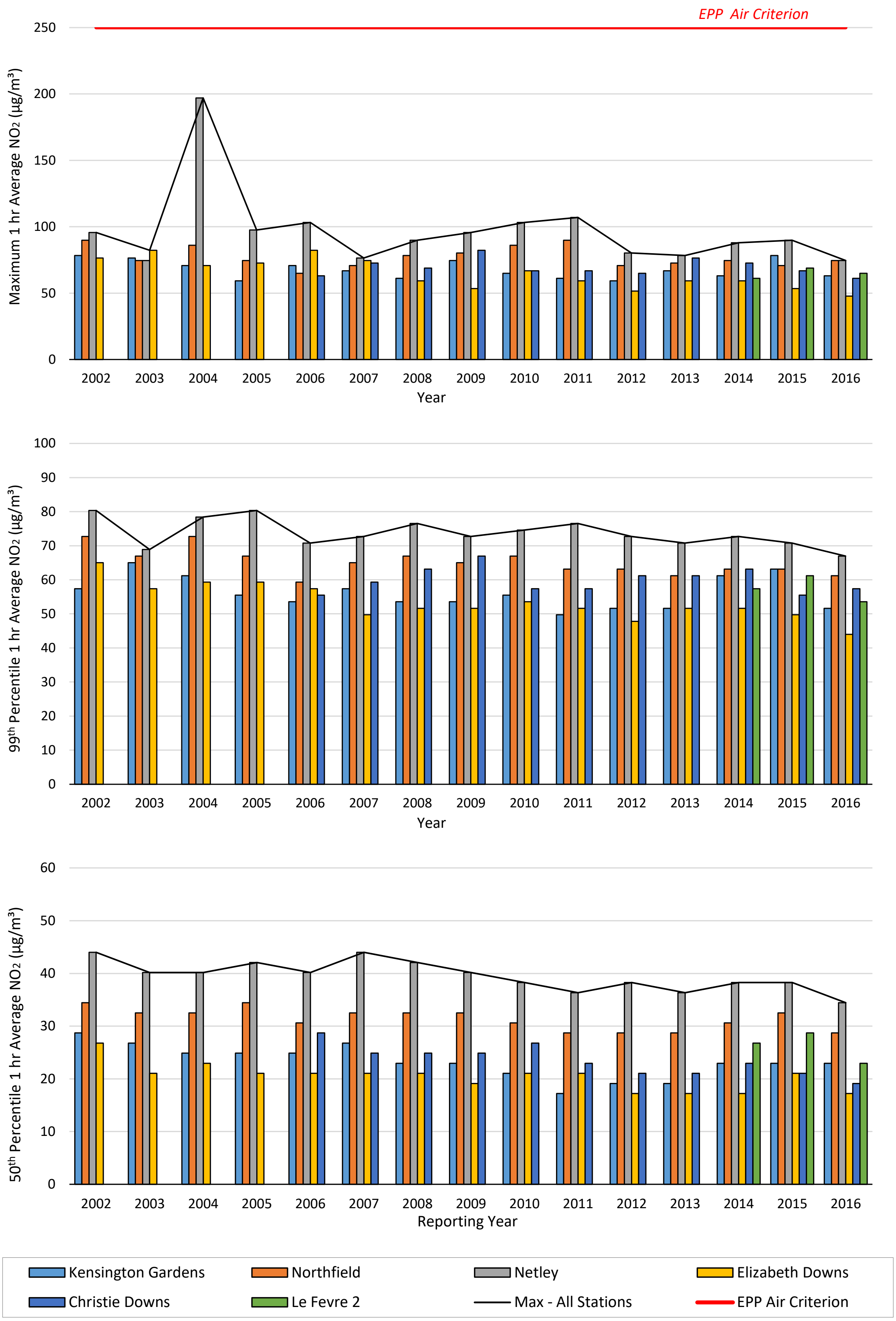


Figure 4-2: Long term trends in maximum, 99th and 50th percentile daily peak NO_2 concentrations

A summary of air quality monitoring data for selected sites are provided in the following sections. The data indicate that generally air quality for the Adelaide metropolitan region is good. Exceedances of the SA EPA criteria are typically limited to particulate matter (PM_{10} and $PM_{2.5}$), with regional PM_{10} (dust storms, bushfires etc.) being the dominant contributor to these exceedances.

4.2 Nitrogen dioxide (NO_2)

The annual statistics for NO_2 are provided in Table 4-1. Based on an average of the maximum 1-hour NO_2 concentrations, the background (for an area represented by these monitoring sites), is approximately 43% of the SA EPA criterion of 250 µg/m³. On an annual basis, the background NO_2 concentrations are approximately 27% of the of the SA EPA criterion of 60 µg/m³.

Table 4-1: Annual NO_2 concentration statistics (µg/m³)

Site	Year	Annual average	1-hour maximum	90th percentile	70th percentile
Assessment criteria	*n/a*	*60*	*250*	*n/a*	*n/a*
Netley	2008	16	90	42	21
	2009	15	96	38	19
	2010	15	103	38	19
	2011	14	107	36	17
	2012	14	80	36	17
	2013	12	88	36	15
	2014	15	88	38	18
	2015	14	90	36	17
	2016	13	75	34	15

4.3 Carbon monoxide (CO)

Background concentrations of CO at Elizabeth Downs are low, as indicated in Table 4-2. Based on the maximum 1-hour CO concentrations, the background is 6% of the SA assessment criterion of 31,240 µg/m³ and the maximum 8-hour background is 7% of the SA assessment criterion of 11,250 µg/m³.

Table 4-2: Annual CO concentration statistics (µg/m3)

Site	Year	1-hour maximum	8-hour maximum	70th percentile 1-hour	70th percentile 8-hour
Assessment criteria	*n/a*	*31,240*	*11,250*	*n/a*	*n/a*
Elizabeth Downs	2008	1,456	460	23	31
	2009	1,072	428	35	39
	2010	1,794	408	35	38
	2011	1,386	782	23	32
	2012	1,619	603	23	28
	2013	1,217	1,106	23	23
	2014	860	238	17	21
	2015	3,005	842	23	23
	2016	769	280	12	21

4.4 Sulphur dioxide (SO_2)

Background concentrations of SO_2 (for the area represented by the Northfield monitoring station) are low, as indicated in Table 4-3, when compared to the SA assessment criteria 60 µg/m^3 (annual average), 230 µg/m^3 (24-hour average) and 570 µg/m^3 (1-hour average).

Table 4-3: Annual SO_2 concentration statistics (µg/m^3)

Site	Year	Annual average	24-hour maximum	1-hour maximum	70th percentile 1 hour
Assessment criteria	*n/a*	*60*	*230*	*570*	*n/a*
Northfield	2008	0.3	5	24	0.0
	2009	0.2	5	59	0.0
	2010	0.2	7	35	2.7
	2011	0.3	11	40	0.0
	2012	0.3	11	29	2.7
	2013	0.4	18	29	0.0
	2014	0.2	4	48	0.0
	2015	0.2	5	27	0.0
	2016	0.1	4	29	0.0

4.5 Particulate Matter as PM_{10}

Concentrations of PM_{10} above the 24-hour criterion (50 µg/m^3) occur at a number of monitoring locations within Adelaide each year. In 2009, 6 days of exceedances of the SA assessment criterion were measured at Netley.

Table 4-4: Annual PM_{10} concentration statistics (µg/m^3)

Site	Year	24-hour maximum	70th percentile
Assessment criteria	*n/a*	*50*	*n/a*
Netley	2008	90	21
	2009	109	21
	2010	94	19
	2011	39	15
	2012	60	19
	2013	65	18
	2014	56	17
	2015	99	17
	2016	35	17

4.6 Particulate Matter as $PM_{2.5}$

Concentrations of $PM_{2.5}$ generally meet the SA EPA assessment criteria. The exception was in 2009, where there was one day which exceeded the 24-hour $PM_{2.5}$ criterion.

Table 4-5: Annual $PM_{2.5}$ concentration statistics (µg/m^3)

Site	Year	Annual Average	24-hour maximum	70th percentile
Assessment criteria	*n/a*	*8*	*25*	*n/a*
Netley	2008	7.7	20	8.6
	2009	8.1	27	9.3
	2010	7.4	20	8.2
	2011	7.1	17	7.8
	2012	7.3	15	8.1
	2013	7.2	25	7.8
	2014	7.4	17	8.2
	2015*	7.2	16.7	8.1
	2016	9.0	21	9.8

Note: *$PM_{2.5}$ monitoring instrumentation changed from Tapered Element Oscillating Microbalance (TEOM) to Beta Attenuation Monitor (BAM) during November 2015.

4.7 Summary of adopted background data

The background pollutant concentrations adopted for the assessment are based on the local monitoring data measured during 2009 and are shown in Table 4-7.

Table 4-6 Summary of adopted background data (µg/m³)

Substance	Averaging period	Adopted background concentration	SA EPA criterion
NO_2	1 hour	Time Varying	250
	Annual	15	60
CO	1-hour [(a)]	35	31,240
	8-hour	39	11,250
SO_2	1 hour	59	570
	24-hour[(b)]	5	230
	Annual	0.2	60
PM_{10}	24 hour	21	50
$PM_{2.5}$	24 hour	9.3	25
	Annual	8.1	8
Formaldehyde	1-hour	n/a	20
Benzene	3 minutes	n/a	58
	Annual	n/a	10
PAHs	3 minutes	n/a	0.8
	Annual	n/a	0.003

Notes: n/a – Pollutant assessed on an incremental basis.

5 Modelling Methodology

The assessment follows a conventional approach commonly used for air quality assessment in Ambient Air Quality Assessment guidelines (SA EPA, 2016b). The CALMET/CALPUFF modelling system was selected for this study. Given the presence of coastal conditions, the use of a non-steady-state model such as CALPUFF provides a distinct advantage in the treatment of calm conditions over steady-state models (such as AERMOD or AUSPLUME), and is also able to address changes in meteorology that occur with changing land, use including coastal fumigation.

Further detail of the modelling methodology is provided within this section.

5.1 CALMET

The regional meteorology has been modelled using CALMET, which is the meteorological pre-processor for the CALPUFF model. From this, a 1-year representative meteorological dataset was compiled (in this case 2009) for CALPUFF. This data includes hourly spatially varying fields of meteorological variables relevant to the estimation of pollutant dispersion.

CALMET is a meteorological pre-processor that includes a wind field generator containing objective analysis and parameterised treatments of slope flows, terrain effects and terrain blocking effects. The pre-processor produces fields of wind components, air temperature, relative humidity, mixing height and other micro-meteorological variables to produce the three-dimensional meteorological fields that are utilised in the CALPUFF dispersion model (i.e. the CALPUFF dispersion model requires meteorological data in three dimensions). CALMET uses the meteorological inputs in combination with land use and geophysical information for the modelling domain to predict gridded meteorological fields for the region.

CALMET was run with an outer grid domain of 300 km x 210 km, encompassing the region of the BIPS with a 2km grid resolution. Upper air data from Adelaide Airport was used to represent meteorological characteristics aloft, whilst 21 Bureau of Meteorology (BoM) weather stations were used to characterise surface conditions.

Figure 5-1 shows the outer CALMET domain and location of assimilated BoM meteorological observations.

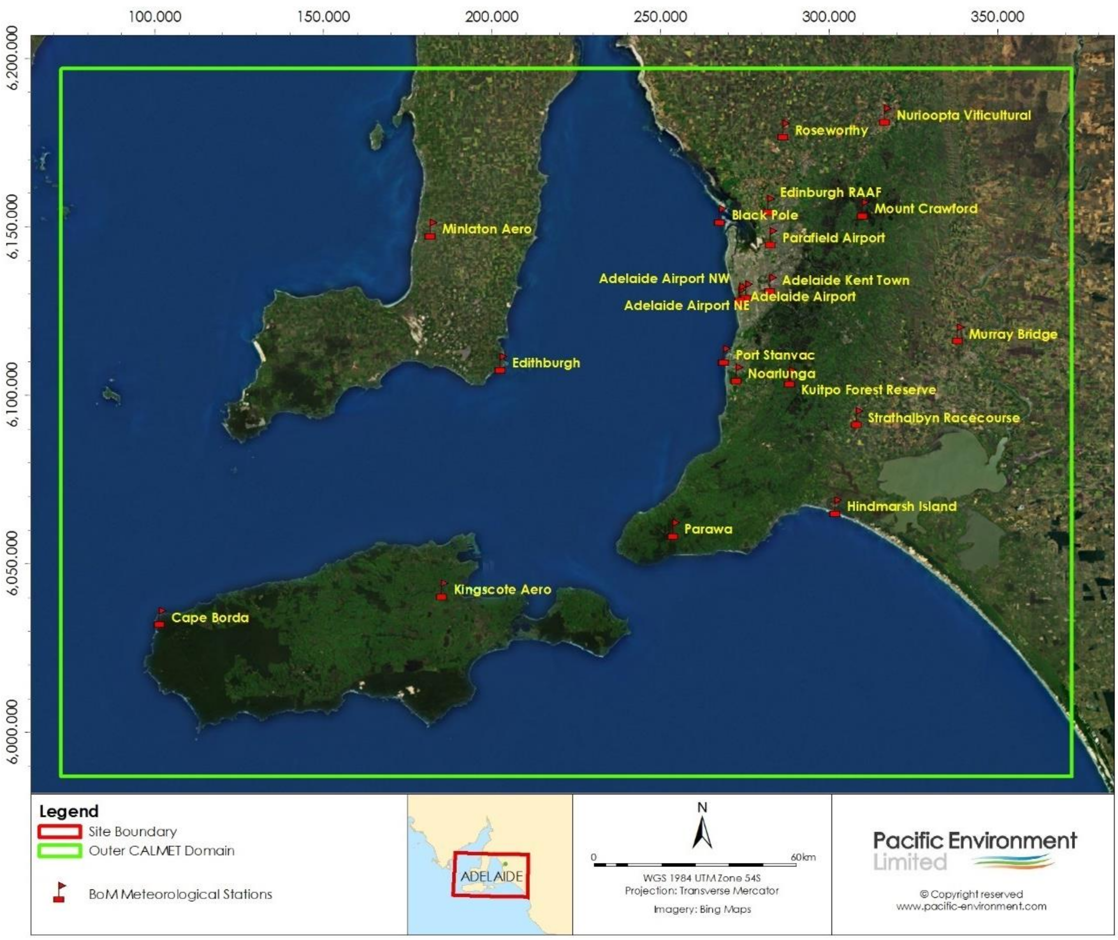


Figure 5-1: CALMET outer domain and location of assimilated BoM meteorological observations

A finer grid resolution of 0.5km with a domain of 30km x 30km was then run for the inner CALMET Domain. Figure 5-2 shows and example inner CALMET wind field overlaid on land use and aerial imagery.

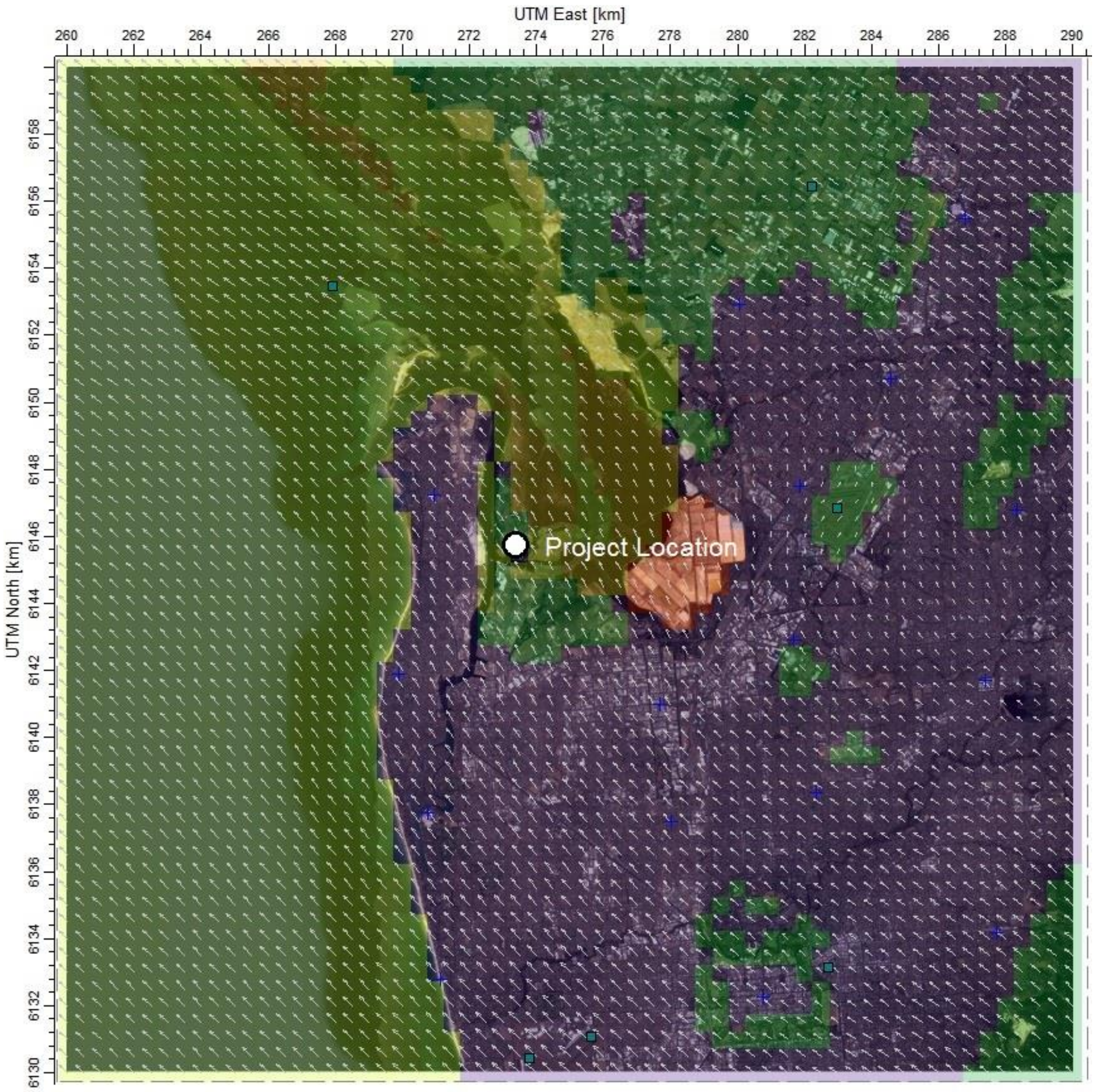


Figure 5-2: Example inner CALMET domain wind field overlaid on land use and aerial imagery

Table 5-1 summarises the model inputs the outer and inner CALMET domains. Details of all model inputs are provided in Appendix A. CALMET wind data have been extracted at the BIPS site and are presented as annual and seasonal wind roses in Figure 5-3.

Table 5-1: Summary of CALMET model Configuration

CALMET Outer grid	
Meteorological grid domain	300 km x 210 km
Meteorological grid resolution	2.0 km
Input data	Assimilation of 21 BoM Surface Stations Upper air data from Adelaide Airport
CALMET Inner grid	
Meteorological grid domain	30 km x 30 km
Meteorological grid resolution	0.5 km
Initial guess field	CALMET Outer Domain
Surface meteorological stations	As per outer grid (assimilation based on distance weighted interpolation)

Figure 5-3: Wind roses generated for the site using CALMET – 2009

5.2 CALPUFF

CALPUFF is a multi-layer, multi-species non-steady state puff dispersion model that can simulate the effects of time and space varying meteorological conditions on pollutant transport, transformation and removal (Scire et al.,2000). The model contains algorithms for near-source effects such as building downwash, partial plume penetration, sub-grid scale interactions as well as longer-range effects such as pollutant removal, chemical transformation, vertical wind shear and coastal interaction effects. The model employs dispersion equations based on a Gaussian distribution of pollutants across the puff and takes into account the complex arrangement of emissions from point, area, volume, and line sources.

5.2.1 Emission Scenarios

The dispersion modelling has incorporated 5 separate emission sources. These sources include:

- BIPS Stack A: Stage 1, Clustered Stack – Serving reciprocating engines 1 - 6.
- BIPS Stack B: Stage 1, Clustered Stack – Serving reciprocating engines 7 - 12.
- BIPS Stack C: Stage 2, Clustered Stack – Serving reciprocating engines 13 - 18.
- BIPS Stack D: Stage 2, Clustered Stack – Serving reciprocating engines 19 - 24.
- TIPS B Stack: TIPS B – Serving boilers 1 – 4 (modelled at both 25% and 100% load).

Emissions have been modelled in the following operational scenarios for both natural gas, and diesel operation:

(1) Stage 1, Project Only

(2) Stage 1 + Stage 2, Project Only

(3) Stage 1, Project with TIPS B emissions (typical operations: 25% load).

(4) Stage 1 + Stage 2, Project with TIPS B emissions (typical operations: 25% load).

(5) Stage 1, Project with TIPS B emissions (maximum operations: 100% load).

(6) Stage 1 + Stage 2, Project with TIPS B emissions (maximum operations: 100% load).

Emissions from TIPS B have been included given they are located in close proximity to the BIPS, and share a similar pollutant profile. TIPS B has been modelled in both 25% load and 100% load scenarios. These two scenarios are considered reflective of typical operations, and the upper limit of operations (respectively).

Based on historic trends, TIPS B has operated at 100% load on 5 – 7 occasions per year, for periods of 3-4 hours, during peak summer demand conditions. The 100% load scenario assumes that this operating condition is present for 8,760 hours per year, and is hence considered highly conservative, especially in the estimation of annual average concentrations.

In order to qualify this conservatism, a 25% load scenario has been included. This load represents 1 of the four TIPS B turbines at full load, and provides a slightly conservative representation of typical (non-peak) operating conditions.

Within each scenario, modelling has also been conducted for natural gas and diesel operation. Table 5-2 provides a summary of modelled emission sources by emission scenario, as reflective of the 6 scenarios listed above.

Table 5-2: Summary of modelled emission sources by emission scenario

Source	Scenario					
	S1	S2	S3	S4	S5	S6
BIPS Stack A	✓	✓	✓	✓	✓	✓
BIPS Stack B	✓	✓	✓	✓	✓	✓
BIPS Stack C		✓		✓		✓
BIPS Stack D		✓		✓		✓
TIPS B			✓ (25% load)	✓(25% load)	✓(100% load)	✓(100% load)

5.2.2 Stack locations

The AGL have provided indicative stack locations for use in the modelling assessment. Table 5-3 provides a summary of modelled exhaust stack locations and dimensions, whilst Figure 5-4 shows the location of the emission sources spatially.

Table 5-3: Summary of emission source locations

Source	Easting (kmE)	Northing (kmN)	Base Elevation (mAGL)	Height (m)	Diameter (m)
BIPS Stack A	273.446	6145.983	3	30	3.92
BIPS Stack B	273.500	6145.948	3		
BIPS Stack C	273.477	6146.032	3		
BIPS Stack D	273.532	6145.996	3		
TIPS B	273.363	6145.771	3	160	7.3

Note: MGA94 coordinates, Zone 54H.

Figure 5-4: Aerial image showing modelled stack locations

5.2.3 Emission parameters

Emission parameters for BIPS have been provided by AGL based on manufacturer information for reciprocating engines that are considered representative of the proposed generation technology and capacity.

Project source emission rates have been prepared base on the following sources:

- Manufacturer information.
- Emission concentrations for a similar facility (AIS, 2016).
- Local fuel standards.
- USEPA (2006). *Compilation of Air Pollutant Emission Factors – Chapter 3: Stationary Internal Combustion Sources*, AP-42, Fifth Edition.

In the case of TIPS B, emission parameters and emission rates have been sourced from the previous assessment for the Site: *Air Quality Assessment – Torrens Island Energy Park – Final* (PAEHolmes, 2009). The exhaust flows and emission rates have been scaled down to 25% for the average operations source configuration.

Table 5-3 presents a summary of source emission parameters and emission rates applied in the modelling.

Table 5-4: Summary of stack emission parameters and emission rates

Parameter	Reciprocating Engine Clustered Stack		Existing TIPS B Stack		Units
	Natural Gas Operation	Diesel Operation	25% Load	100% Load	
Emission Parameters					
Exit Temp.	378[(1)]	354[(1)]	105[(2)]		°C
Exit Velocity	29[(1)]	31[(1)]	5.5[(3)]	21.9[(2)]	m/s
Emission Rates					
NO_x as NO_2	*28.7*[(1)]	*40.8*[(1)]	*55.8*[(3)]	*223*[(2)]	*g/s*
CO	*35.7*[(1)]	*13.4*[(1)]	3.5[(3)]	13.8[(2)]	*g/s*
SO_2	*0.65*[(4)]	*0.06*[(4)]	0.14[(3)]	0.57[(2)]	*g/s*
$PM_{2.5}$, PM_{10}	*1.30*[(5)]	*4.6*[(5)]	1.8[(3)]	7.3[(2)]	*g/s*
Formaldehyde	*0.76*[(1)]	*0.01*[(6)]	*0.02*[(3)]	*0.07*[(2)]	*g/s*
Benzene	*0.19*[(6)]	*0.08*[(6)]	*0.0005*[(3)]	*0.002*[(2)]	*g/s*
Benzo(a)pyrene	*2.3×10^{-6}* [(6)]	*2.3×10^{-4}* [(6)]	*0.0002*[(3)]	*0.0007*[(2)]	*g/s*

Source:

(1) Provided by AGL

(2) PAEHolmes (2009)

(3) Scaled from PAEHolmes (2009) to reflect reduced volumetric flow at part load.

(4) Estimated based on fuel sulphur contents of 50 mg/sm³ (natural gas fuel), 10 mg/kg (diesel fuel).

(5) Estimated based on AIS (2016)

(6) Estimated based on USEPA (2006).

5.2.4 Modelling domain

The model configuration requires designation of the spatial location of model receptors, which are points at which model concentration outputs are generated. The model has used both gridded and discrete receptors as per the following:

- Gridded receptors have been incorporated on a 30 x 30 km receptor grid equating to a total of 3,721 gridded receptors. This domain extent is considered adequate for the capture of peak model predictions.
- 16 discrete receptors have been allocated to suburbs across the gridded modelling domain.

Table 5-5 provides a summary of modelled discrete receptor locations, whilst Figure 5-5 shows the gridded receptor domain extent and discrete receptor locations.

Table 5-5: Summary of modelled suburban discrete receptor locations

Receptor	Suburb	Easting (kmE)	Northing (kmN)
1	Adelaide	280.8	6132.3
2	Broadview	282.3	6138.4
3	Burton	280.0	6152.9
4	Croydon Park	278.0	6137.5
5	Elizabeth	286.8	6155.5
6	Henley Beach	271.1	6132.8
7	Holden Hill	287.4	6141.7
8	Magill	287.7	6134.2
9	North Haven	270.9	6147.2
10	Parafield Gardens	281.9	6147.5
11	Pooraka	281.7	6142.9
12	Salisbury	284.6	6150.7
13	Semaphore	269.9	6141.9
14	West Lakes	270.7	6137.8
15	Wingfield	277.7	6141.0
16	Wynn Vale	288.4	6146.8

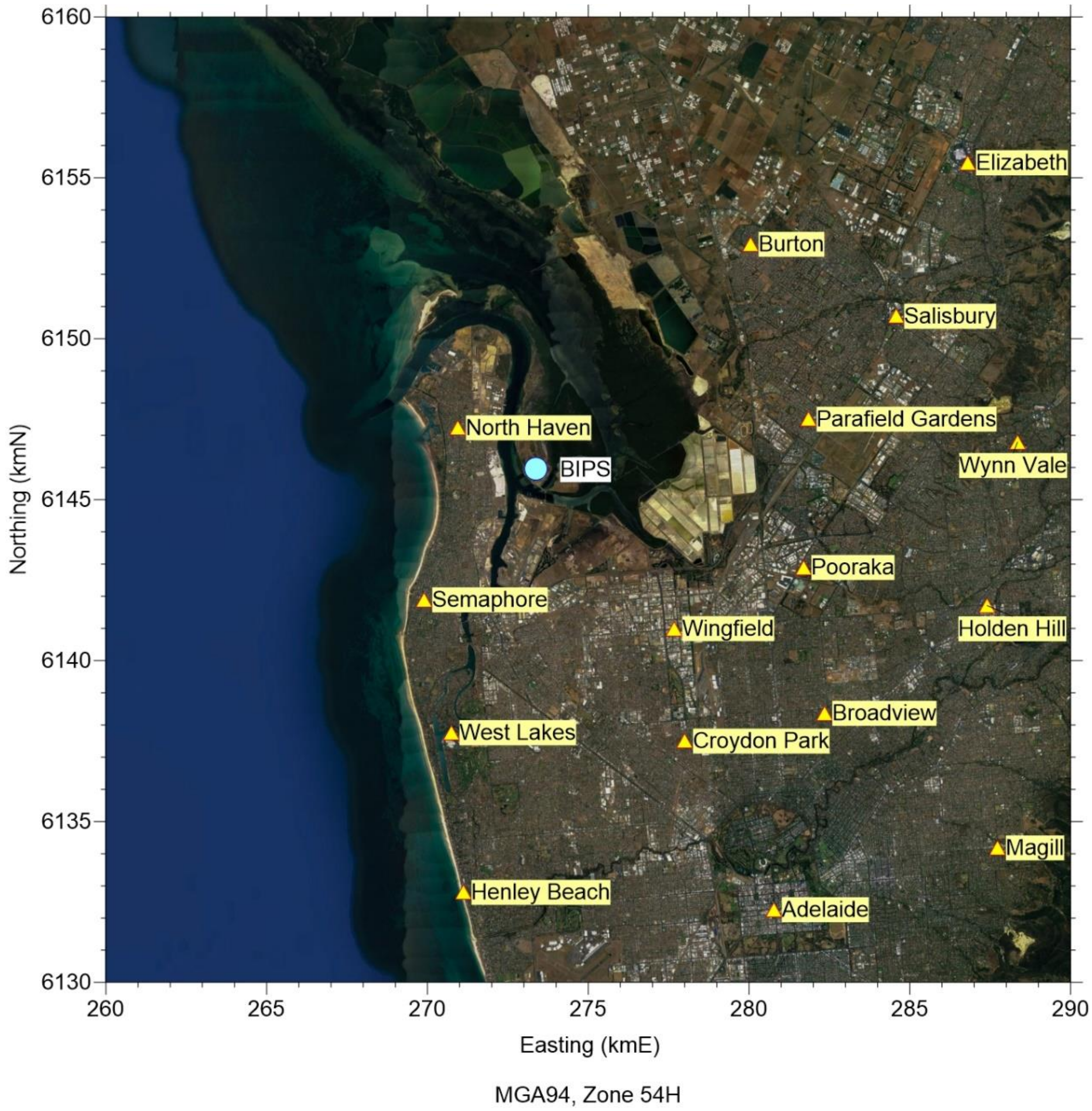


Figure 5-5: Aerial image showing gridded receptor domain extent and discrete receptor locations

(Base image sourced from Google Earth Pro)

5.2.5 Nitrogen dioxide modelling

Oxides of nitrogen (NO_x) is emitted primarily as nitric oxide (NO) and nitrogen dioxide (NO_2). The amount of NO_2 in the exhaust stream as it is released from combustion sources is typically in the order of 5-10% of total NO_x. However, following release the NO_2 proportion (of emitted NO_x) changes primarily through reactions between of atmospheric ozone and NO.

Several approaches are available to estimate the transformation of NO to NO_2 that occurs after the exhaust gases are discharged. For this assessment, the Ozone Limiting Method (OLM) has been used to calculate NO_2 concentrations. The OLM is based on the assumption that 10% of the NO_x emissions occur as NO_2 (EPA, 2016), with the remaining NO being converted over to NO_2 until all of the ambient ozone until all of the ambient ozone is consumed. In this respect, the conversion is limited by the availability of ozone.

Equation 5-1 shows the mathematical relationship applied in the OLM modelling:

$$[NO_{2p}] = \min\left(\left(0.1 \times [NO_{Xp}] + \frac{46}{48}[O_{3m}]\right) or ([NO_{Xp}])\right)$$

(Equation 5-1)

Where:

$[NO_{2p}]$ = predicted NO_2 concentration (µg/m³)

$[NO_{xp}]$ = predicted NO_x concentration (µg/m³)

$[O_{3m}]$ = measured O_3 concentration (µg/m³)

The ozone concentrations applied were based on hourly monitoring data from the Netley ambient air quality monitoring station (located approximately 10 km south of the site) (SA EPA, 2014). Ozone and NO_2 data were 97.4% and 97.3% complete (respectively) for the year 2009. Data gaps of 1 hour were filled by linear interpolation which brought the data availability to 99.8% (both datasets). Remaining missing values (0.2%) were substituted with average values in order to provide a complete dataset.

Hourly NO_2 predictions were processed using the OLM in conjunction with corresponding hourly Ozone and NO_2 background data.

5.2.6 Sub-hourly averaging periods

The assessment of formaldehyde, benzene and PAHs requires estimation of pollutant concentrations over 3 minute averaging periods.

Hourly averaged model predictions have been converted to 3 minute averaging periods using the power law conversion provided in the EPA Victoria draft guideline *Guidance notes for using the regulatory air pollution model AERMOD in Victoria* (EPAV, 2013). This conversion accounts for fluctuations in pollutant levels within the larger averaging period, and is provided in Equation 5-2:

$$C_{3\,min} = C_{1\,hour} \times \left(\frac{60}{3}\right)^{0.2}$$

(Equation 5-2)

Where:

$C_{1\,hour}$ is the 1 hour average prediction.
$C_{3\,min}$ is the 3 minute average prediction.

5.2.7 Building downwash

Aerodynamic wakes are produced as air travels over irregular objects such as building structures. Within these wakes, there is a high level of turbulence and vertical mixing. In instances where exhaust plumes interact with these wakes, pollutants can be mixed downward to ground level, producing locally elevated concentrations, and otherwise reducing the scale of plume rise at distances downwind of the source. Within dispersion modelling, this effect is referred to as building downwash.

For this study, emission sources were screened for potential interaction with building wakes, where wakes extend:

- by a distance of 5 x L from the leeward edge of a wake producing structure, where L is the lesser of the structure height or the projected structure width.
- to a height of 2.5 times the height of the structure.

Stacks for the BIPS have been sized as to avoid building downwash from the BIPS engine hall structures. Noting this, given the proximity of the Stage 1 plant to the TIPS B turbine hall and boiler structures, these structures have been incorporated into the calculation of building downwash effects using the Building Profile Input Program (BPIP), with treatment of these effects using the Plume Rise Model Enhancement (PRIME) building downwash algorithms.

A visual representation of the model representation of TIPS B building structures relative to the TIPS and BIPS stack structures is provided in Figure 5-6.

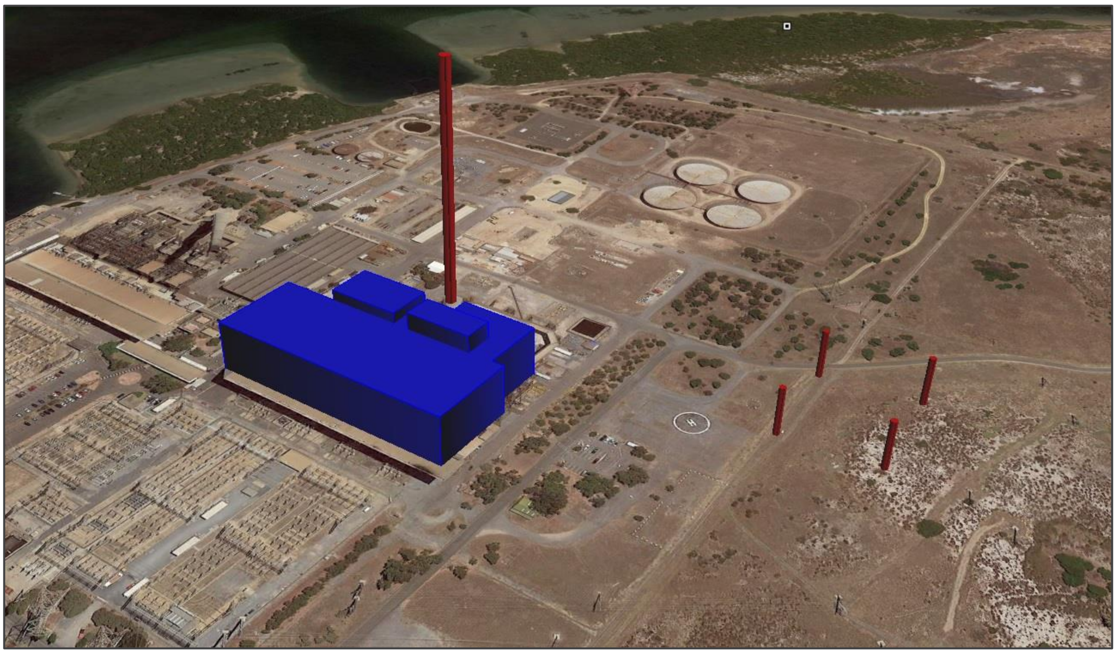


Figure 5-6: Visual representation of building structures included in the treatment of building downwash effects.

(Image sourced from Google Earth Pro)

5.2.8 Plume merging

The proposed BIPS exhaust stacks are located in a rectangular configuration, with horizontal separation of approximately 57 m and 64 m across each dimension. During operation at peak load, each plume will possess a sensible heat flux in the vicinity of 100 MW. Given the scale of this heat release, it is anticipated that these buoyant plumes will rise rapidly in the atmosphere, and merge with neighbouring plumes. It is noted that at the point of merging, the combined buoyancy of the merged plume would produce an accelerated rate and extent of plume rise, beyond that which would occur for an individual plume.

Within this assessment, plume merging effects have been ignored. In the investigation of local air quality impacts, this approach is considered conservative.

5.2.9 Other model options

A summary of other model options has been provided in Appendix A.

6 Results

This section provides a summary of the results of the dispersion modelling, with comparison against SA EPA air quality impact assessment criteria. Results have been provided both in tabulated form, and as contour isopleths for select modelling scenarios. All results are presented in the mass-based units of micrograms per cubic metre (µg/m³).

The modelling has considered dispersion of a range of pollutants for the following operational scenarios:

(1) Stage 1, Project Only – Natural Gas Operation

(2) Stage 1, Project Only – Diesel Operation

(3) Stage 1 + Stage 2, Project Only – Natural Gas Operation

(4) Stage 1 + Stage 2, Project Only – Diesel Operation

(5) Stage 1, Project – Natural Gas Operation, TIPS B (typical load).

(6) Stage 1, Project – Diesel Operation with TIPS B (typical load).

(7) Stage 1 + Stage 2, Project – Natural Gas Operation, with TIPS B (typical load).

(8) Stage 1 + Stage 2, Project – Diesel Operation with TIPS B (typical load).

(9) Stage 1, Project – Natural Gas Operation, with TIPS B (maximum load).

(10) Stage 1, Project – Diesel Operation with TIPS B (maximum load).

(11) Stage 1 + Stage 2, Project – Natural Gas Operation, with TIPS B (maximum load).

(12) Stage 1 + Stage 2, Project – Diesel Operation with TIPS B (maximum load).

Noting the range of pollutants, averaging periods, and cumulative and incremental statistics, contour isopleths of modelling results have been limited to include assessment of the following statistics:

- Maximum 1 hour incremental and cumulative NO_2 for all scenarios.
- Scenarios (11) and (12) for all other pollutants.

This approach provides an opportunity to differentiate between various pollutant predictions, whilst also understanding the spatial characteristics of worst case modelling predictions.

6.1 NO_2 and $PM_{2.5}$

6.1.1 Results tables

Table 6-1 through Table 6-3 present NO_2 and $PM_{2.5}$ predictions, with assessment against relevant impact assessment criteria.

Table 6-1: Project Only – Incremental and maximum cumulative predictions (µg/m³)

Receptor	Stage 1				Stage 1 + Stage 2			
	NO_2		$PM_{2.5}$		NO_2		$PM_{2.5}$	
	Max. 1-hour	Annual	Max 24-hour	Annual	Max. 1-hour	Annual	Max 24-hour	Annual
Natural Gas								
Adelaide	10	0.1	<0.1	<0.1	17	0.1	0.1	<0.1
Broadview	10	0.1	0.1	<0.1	20	0.2	0.1	<0.1
Burton	14	0.3	0.1	<0.1	21	0.5	0.2	<0.1
Croydon Park	13	0.1	0.1	<0.1	24	0.2	0.1	<0.1
Elizabeth	11	0.1	0.1	<0.1	21	0.2	0.2	<0.1
Henley Beach	19	0.2	0.1	<0.1	27	0.3	0.3	<0.1
Holden Hill	12	0.1	0.1	<0.1	24	0.1	0.1	<0.1
Magill	9	0.1	<0.1	<0.1	13	0.1	0.1	<0.1
North Haven	44	0.2	0.2	<0.1	56	0.4	0.4	<0.1
Parafield Gardens	25	0.1	0.1	<0.1	36	0.3	0.3	<0.1
Pooraka	16	0.1	0.1	<0.1	32	0.2	0.2	<0.1
Salisbury	22	0.1	0.1	<0.1	34	0.2	0.2	<0.1
Semaphore	31	0.6	0.5	<0.1	44	1.0	1.1	0.1
West Lakes	20	0.3	0.2	<0.1	35	0.5	0.4	<0.1
Wingfield	23	0.1	0.1	<0.1	45	0.2	0.2	<0.1
Wynn Vale	10	0.1	<0.1	<0.1	20	0.1	0.1	<0.1
Grid Maximum	80	0.9	1.3	<0.1	89	1.2	1.7	0.1
Diesel								
Adelaide	13	0.1	0.1	<0.1	21	0.2	0.3	<0.1
Broadview	14	0.1	0.2	<0.1	28	0.3	0.5	<0.1
Burton	15	0.4	0.4	<0.1	29	0.7	0.7	0.1
Croydon Park	18	0.1	0.2	<0.1	36	0.3	0.4	<0.1
Elizabeth	15	0.2	0.3	<0.1	30	0.3	0.6	<0.1
Henley Beach	20	0.2	0.5	<0.1	32	0.4	0.9	0.1
Holden Hill	16	0.1	0.2	<0.1	32	0.2	0.5	<0.1
Magill	12	0.1	0.2	<0.1	18	0.2	0.3	<0.1
North Haven	48	0.3	0.6	<0.1	66	0.5	1.2	0.1
Parafield Gardens	34	0.2	0.5	<0.1	39	0.4	1.2	<0.1
Pooraka	22	0.1	0.3	<0.1	45	0.3	0.5	<0.1
Salisbury	30	0.2	0.3	<0.1	40	0.3	0.5	<0.1
Semaphore	39	0.8	1.9	0.1	48	1.3	3.7	0.2
West Lakes	28	0.4	0.7	0.1	48	0.7	1.3	0.1
Wingfield	33	0.2	0.3	<0.1	47	0.3	0.6	<0.1
Wynn Vale	14	0.1	0.1	<0.1	28	0.2	0.3	<0.1
Grid Maximum	83	1.2	4.3	0.2	96	1.5	5.7	0.3
Assessment								
Background	96*	15	9.3	8.1	96*	15	9.3	8.1
Maximum Incremental	83*	1.2	4.3	0.2	96*	1.5	5.7	0.3
Maximum Cumulative	117*	16.2	13.6	8.3	121*	16.5	15.0	8.4
Criterion	250	60	25.0	8.0	250	60	25.0	8.0

Note: *NO_2 cumulative levels are non-additive (from maxima) due to the use of time-varying background concentrations.

Table 6-2: Project with TIPS B typical operations – incremental and maximum cumulative results (µg/m³)

Receptor	Stage 1				Stage 1 + Stage 2			
	NO_2		$PM_{2.5}$		NO_2		$PM_{2.5}$	
	Max. 1-hour	Annual	Max 24-hour	Annual	Max. 1-hour	Annual	Max 24-hour	Annual
Natural Gas								
Adelaide	15	0.1	0.1	<0.1	17	0.1	0.2	<0.1
Broadview	16	0.2	0.1	<0.1	19	0.2	0.3	<0.1
Burton	21	0.5	0.2	<0.1	25	0.6	0.5	0.1
Croydon Park	16	0.2	0.1	<0.1	19	0.2	0.2	<0.1
Elizabeth	15	0.2	0.1	<0.1	18	0.3	0.4	<0.1
Henley Beach	20	0.3	0.2	<0.1	22	0.3	0.5	<0.1
Holden Hill	16	0.1	0.1	<0.1	20	0.2	0.3	<0.1
Magill	13	0.1	0.1	<0.1	15	0.1	0.2	<0.1
North Haven	53	0.4	0.3	<0.1	63	0.4	0.7	<0.1
Parafield Gardens	35	0.3	0.3	<0.1	37	0.3	0.7	<0.1
Pooraka	21	0.2	0.2	<0.1	26	0.3	0.3	<0.1
Salisbury	27	0.2	0.1	<0.1	32	0.3	0.3	<0.1
Semaphore	41	0.9	0.6	0.1	43	1.1	1.9	0.1
West Lakes	26	0.5	0.3	<0.1	32	0.6	0.7	0.1
Wingfield	44	0.3	0.1	<0.1	46	0.3	0.3	<0.1
Wynn Vale	21	0.1	0.1	<0.1	23	0.1	0.2	<0.1
Grid Maximum	88	1.1	1.3	0.1	95	1.5	1.7	0.1
Diesel								
Adelaide	21	0.2	9.5	8.1	27	0.2	0.3	<0.1
Broadview	25	0.3	9.6	8.1	32	0.4	0.5	<0.1
Burton	31	0.8	9.8	8.1	39	1.0	0.8	0.1
Croydon Park	26	0.3	9.5	8.1	36	0.4	0.5	<0.1
Elizabeth	24	0.4	9.7	8.1	33	0.5	0.6	<0.1
Henley Beach	30	0.4	9.8	8.1	33	0.5	1.0	0.1
Holden Hill	26	0.2	9.6	8.1	35	0.3	0.5	<0.1
Magill	19	0.2	9.5	8.1	24	0.2	0.4	<0.1
North Haven	66	0.5	10.0	8.1	69	0.6	1.3	0.1
Parafield Gardens	40	0.4	10.0	8.1	44	0.5	1.3	<0.1
Pooraka	34	0.3	9.6	8.1	46	0.4	0.6	<0.1
Salisbury	34	0.3	9.6	8.1	41	0.4	0.6	<0.1
Semaphore	46	1.3	11.2	8.2	51	1.5	3.8	0.3
West Lakes	41	0.7	10.0	8.1	52	0.8	1.4	0.1
Wingfield	47	0.4	9.6	8.1	49	0.5	0.6	<0.1
Wynn Vale	28	0.2	9.5	8.1	34	0.2	0.3	<0.1
Grid Maximum	91	1.3	4.3	0.2	101	1.8	5.7	0.3
Assessment								
Background	96*	15	9.3	8.1	96*	15	9.3	8.1
Maximum Incremental	91*	1.3	11.2	8.2	101*	1.8	5.7	0.3
Maximum Cumulative	120*	16.3	20.5	16.3	130*	16.8	15.0	8.4
Criterion	250	60	25.0	8.0	250	60	25.0	8.0

Note: *NO_2 cumulative levels are non-additive (from maxima) due to the use of time-varying background concentrations

Table 6-3: Project with TIPS B (maximum load) – incremental and maximum cumulative predictions (µg/m³)

Receptor	Stage 1 NO$_2$ Max. 1-hour	Stage 1 NO$_2$ Annual	Stage 1 PM$_{2.5}$ Max 24-hour	Stage 1 PM$_{2.5}$ Annual	Stage 1 + Stage 2 NO$_2$ Max. 1-hour	Stage 1 + Stage 2 NO$_2$ Annual	Stage 1 + Stage 2 PM$_{2.5}$ Max 24-hour	Stage 1 + Stage 2 PM$_{2.5}$ Annual
Natural Gas								
Adelaide	24	0	0.1	<0.1	31	0.3	0.2	<0.1
Broadview	32	0	0.3	<0.1	38	0.5	0.3	<0.1
Burton	56	1	0.3	<0.1	58	1.2	0.4	<0.1
Croydon Park	37	0	0.2	<0.1	39	0.5	0.2	<0.1
Elizabeth	30	1	0.2	<0.1	36	0.6	0.3	<0.1
Henley Beach	29	1	0.3	<0.1	34	0.6	0.4	<0.1
Holden Hill	32	0	0.2	<0.1	40	0.4	0.3	<0.1
Magill	26	0	0.2	<0.1	32	0.3	0.2	<0.1
North Haven	72	1	0.6	<0.1	74	0.7	0.8	<0.1
Parafield Gardens	47	1	0.3	<0.1	56	0.7	0.5	<0.1
Pooraka	43	0	0.2	<0.1	51	0.6	0.3	<0.1
Salisbury	43	1	0.3	<0.1	53	0.6	0.4	<0.1
Semaphore	58	1	0.7	0.1	59	1.8	1.2	0.1
West Lakes	54	1	0.4	<0.1	56	1.1	0.6	0.1
Wingfield	54	1	0.3	<0.1	63	0.7	0.4	<0.1
Wynn Vale	57	0	0.2	<0.1	60	0.3	0.2	<0.1
Grid Maximum	102	2	1.3	0.1	119	2.0	1.7	0.1
Diesel								
Adelaide	27	0	0.2	<0.1	37	0.4	0.4	<0.1
Broadview	34	0	0.4	<0.1	43	0.6	0.7	<0.1
Burton	57	1	0.6	0.1	59	1.4	0.9	0.1
Croydon Park	38	0	0.3	<0.1	43	0.6	0.5	<0.1
Elizabeth	32	1	0.4	<0.1	42	0.7	0.7	0.1
Henley Beach	31	1	0.6	<0.1	38	0.7	1.1	0.1
Holden Hill	35	0	0.3	<0.1	44	0.4	0.6	<0.1
Magill	28	0	0.3	<0.1	37	0.4	0.4	<0.1
North Haven	73	1	0.9	0.1	77	0.8	1.4	0.1
Parafield Gardens	51	1	0.7	<0.1	65	0.8	1.4	0.1
Pooraka	47	1	0.4	<0.1	55	0.6	0.7	<0.1
Salisbury	48	1	0.5	<0.1	60	0.7	0.8	<0.1
Semaphore	58	2	2.0	0.2	60	2.0	3.9	0.3
West Lakes	55	1	0.9	0.1	60	1.2	1.5	0.1
Wingfield	57	1	0.5	<0.1	70	0.8	0.8	0.1
Wynn Vale	58	0	0.3	<0.1	60	0.4	0.4	<0.1
Grid Maximum	108	2	4.3	0.2	130	2.2	5.7	0.3
Assessment								
Background	96*	15	9.3	8.1	96*	15	9.3	8.1
Maximum Incremental	108*	1.8	4.3	0.2	130*	2.2	5.7	0.3
Maximum Cumulative	140*	16.8	13.6	8.3	163*	17.2	15.0	8.4
Criterion	250	60	25	8	250	60	25	8

Note: *NO$_2$ cumulative levels are non-additive (from maxima) due to the use of time-varying background concentrations.

6.1.2 NO_2 contour isopleths

A full suite of contour isopleths have been provided for 1 hour average incremental NO_2 predictions. Given the use of time varying background concentrations, cumulative (i.e. including background) versions of these plots have been provided in Appendix B.

In addition, annual average NO_2 contour isopleths have been presented for Stage 1 + Stage 2 operations, with TIPS B (maximum load) modelling scenarios.

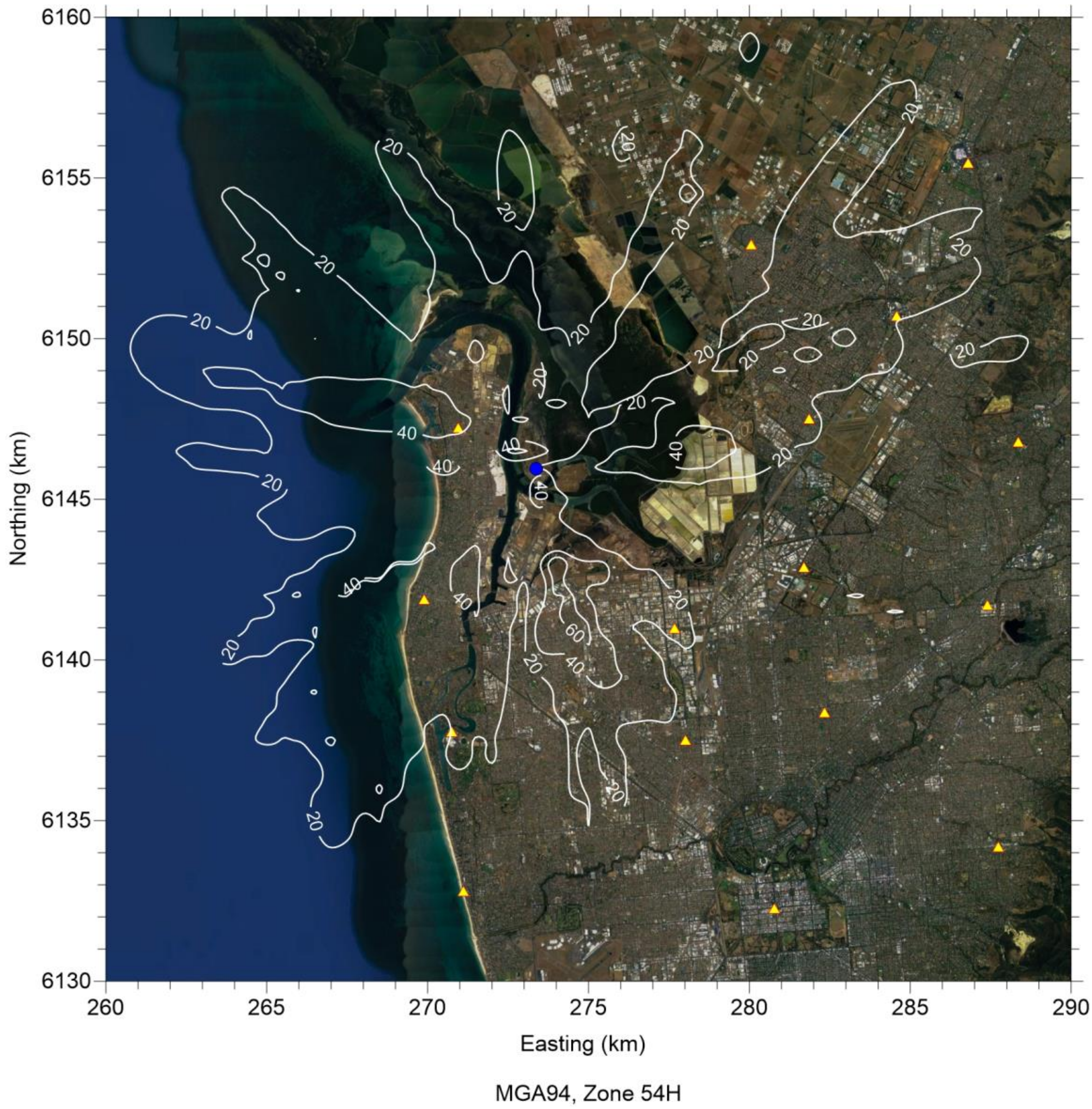


Figure 6-1: Stage 1, Project Only – Natural Gas Operation, incremental maximum 1 hour NO_2 (µg/m³)

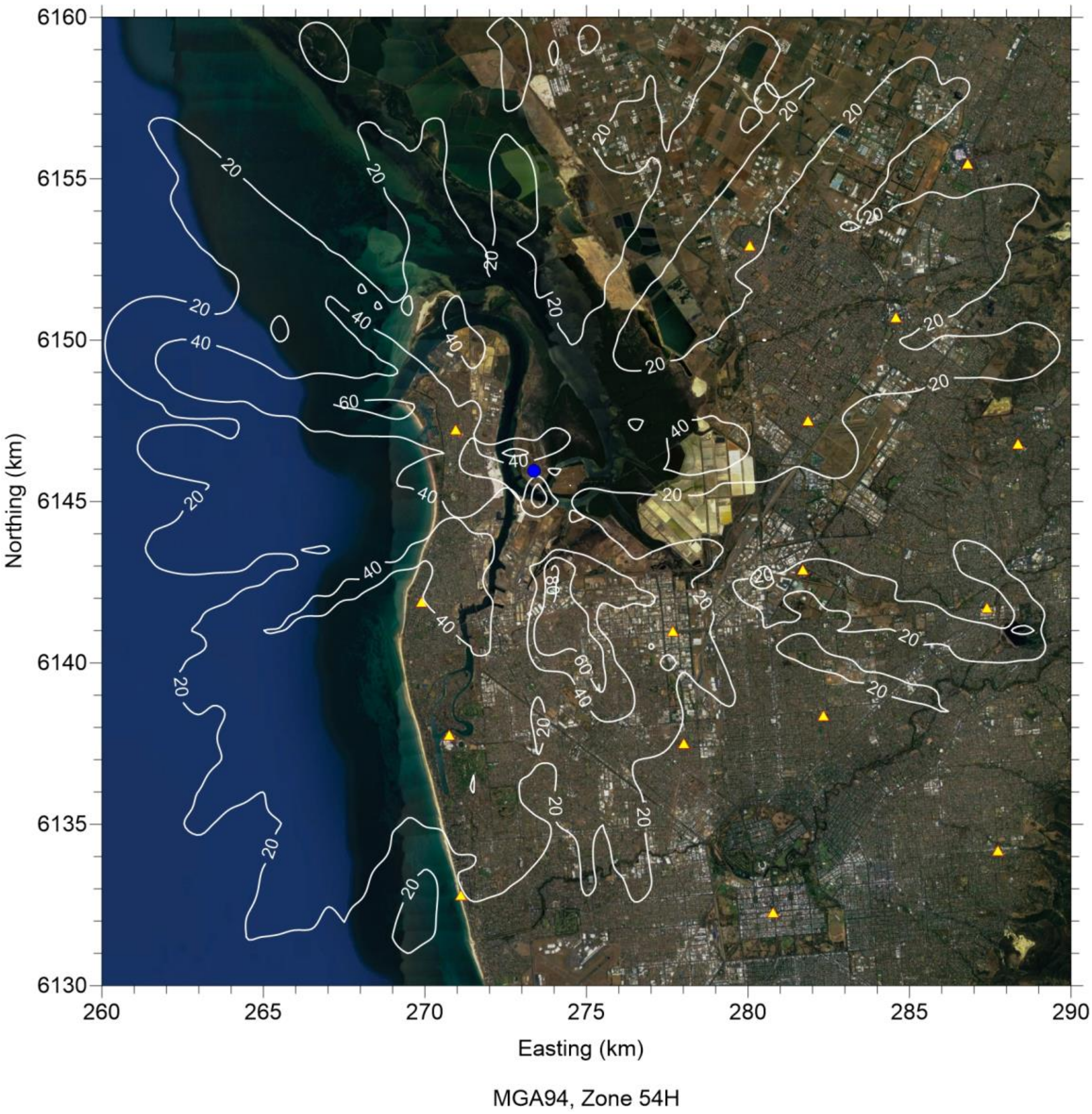


Figure 6-2: Stage 1, Project Only – Diesel Operation, incremental maximum 1 hour NO_2 (µg/m³)

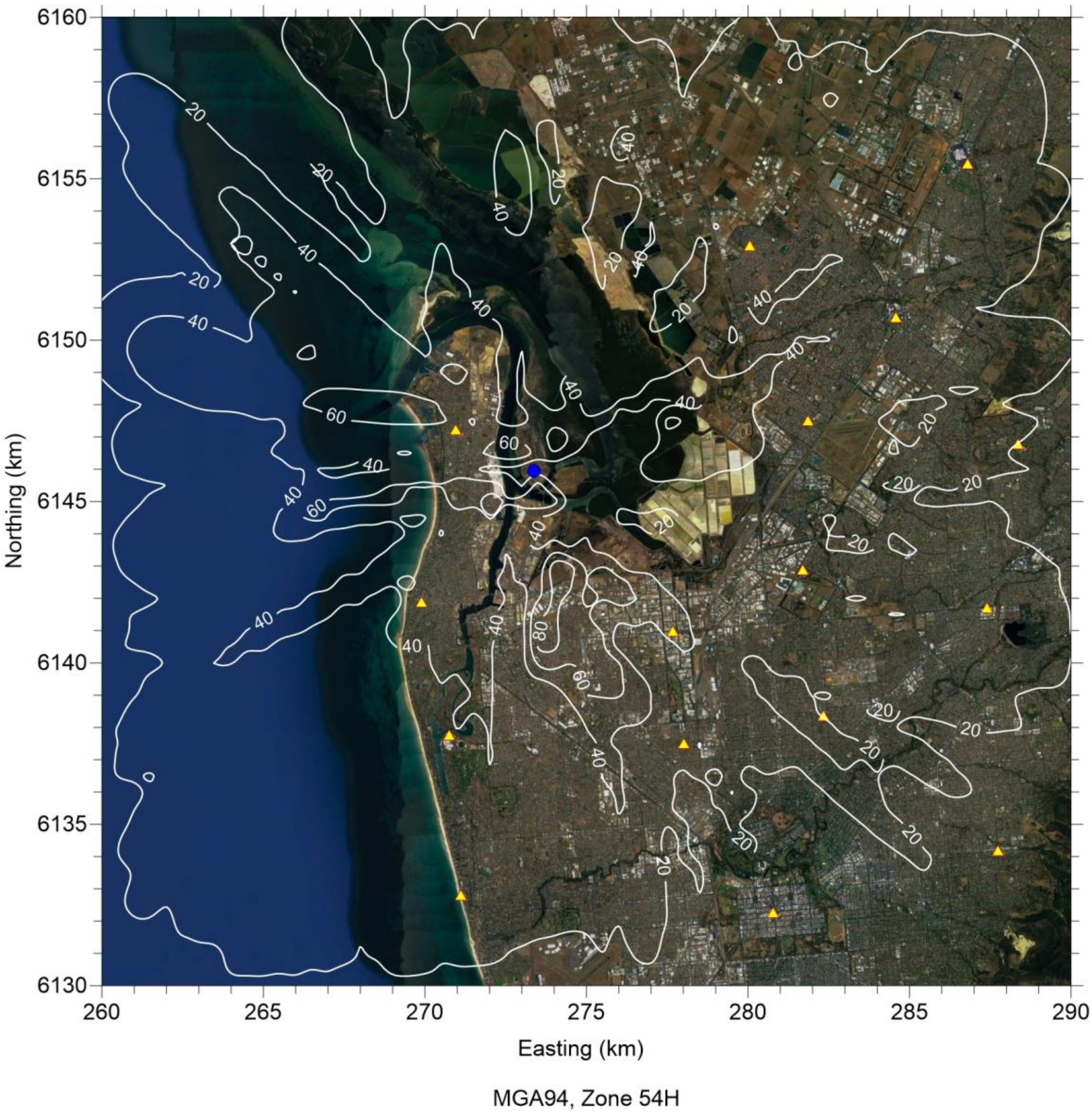


Figure 6-3: Stage 1 + Stage 2, Project Only – Natural Gas Operation, incremental maximum 1 hour NO_2 (µg/m³)

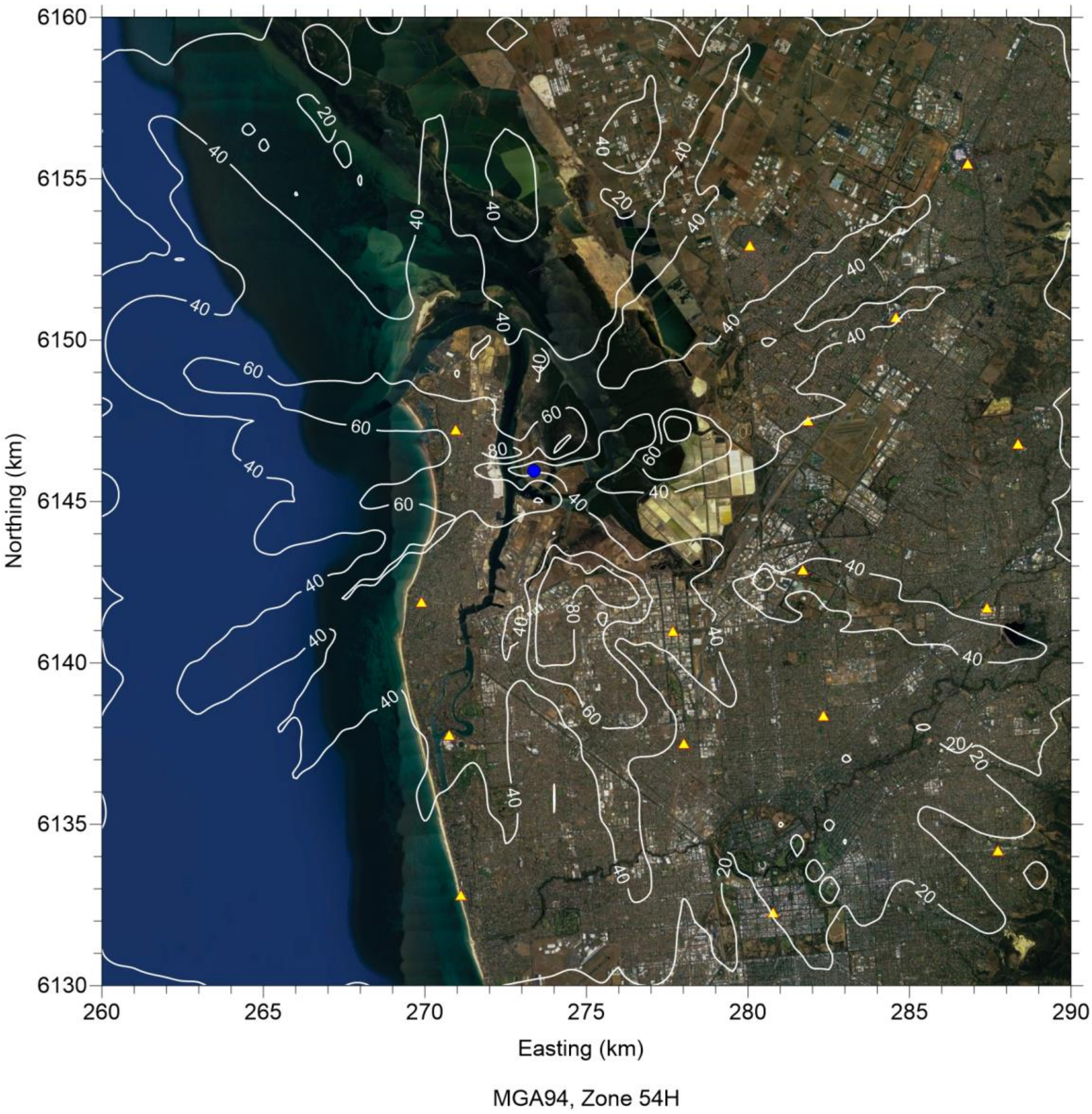


Figure 6-4: Stage 1 + Stage 2, Project Only – Diesel Operation, incremental maximum 1 hour NO_2 (µg/m³)

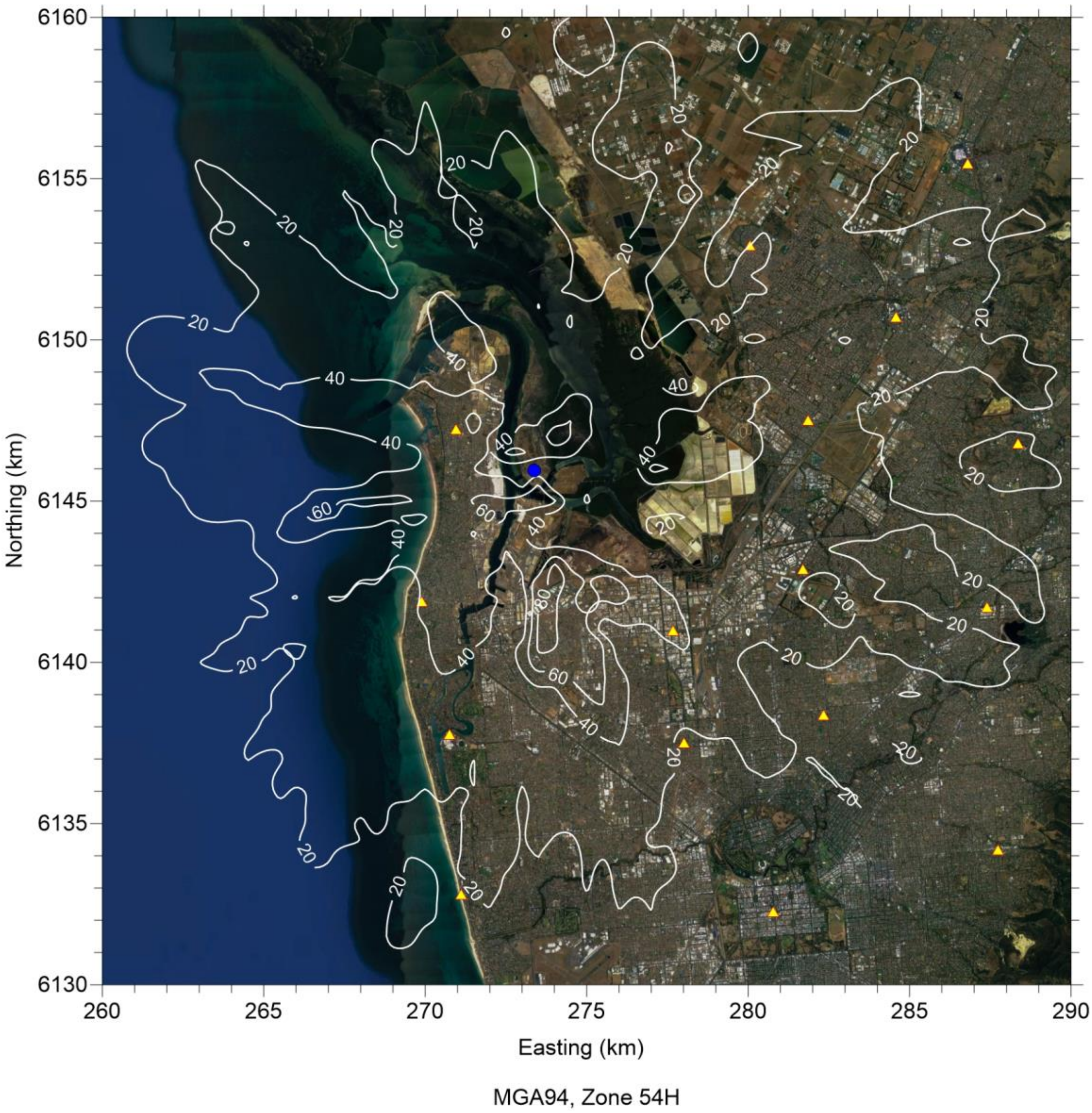


Figure 6-5: Stage 1, Project – Natural Gas Operation, TIPS B (typical load), incremental maximum 1 hour NO_2 (µg/m³)

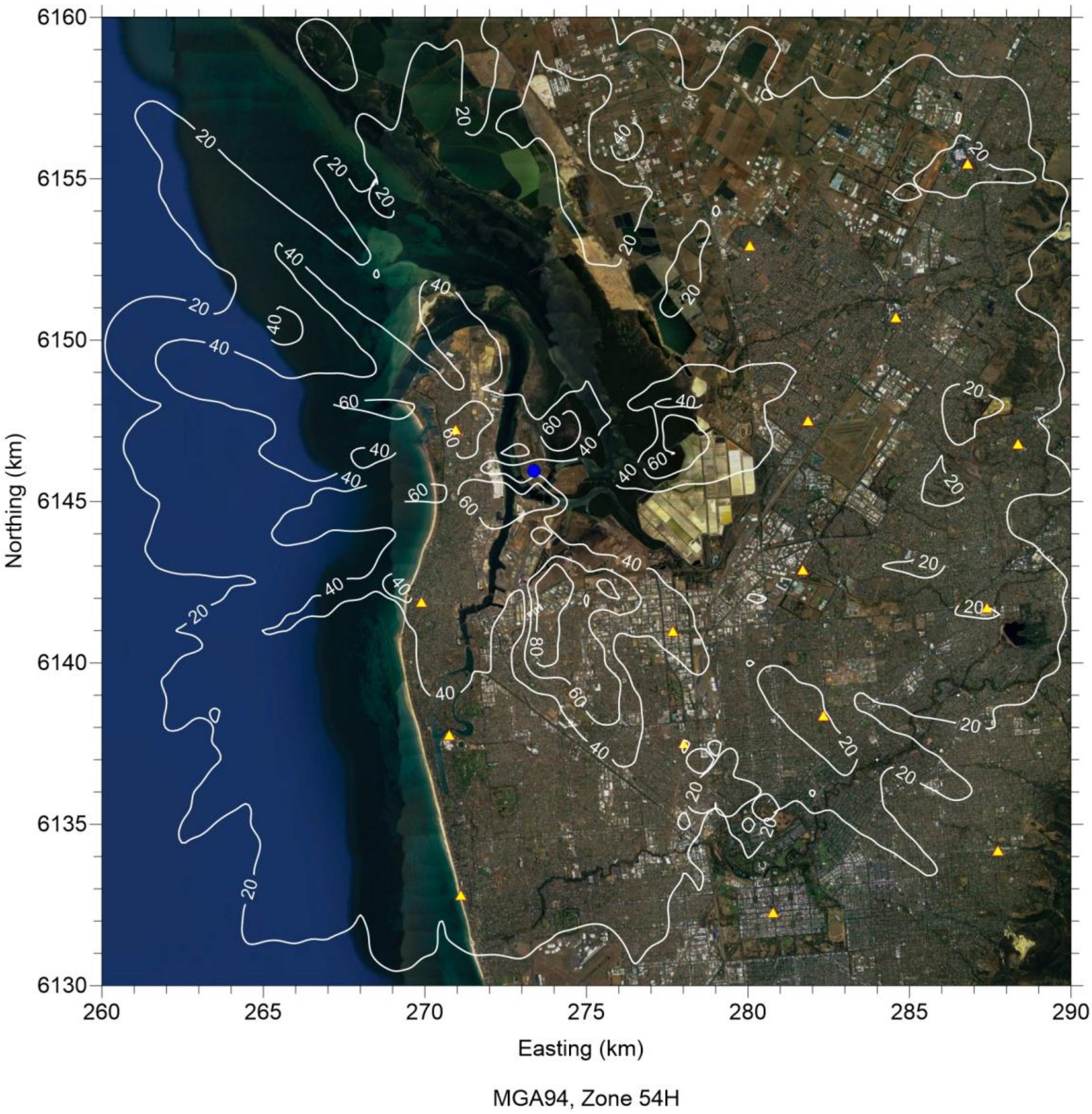
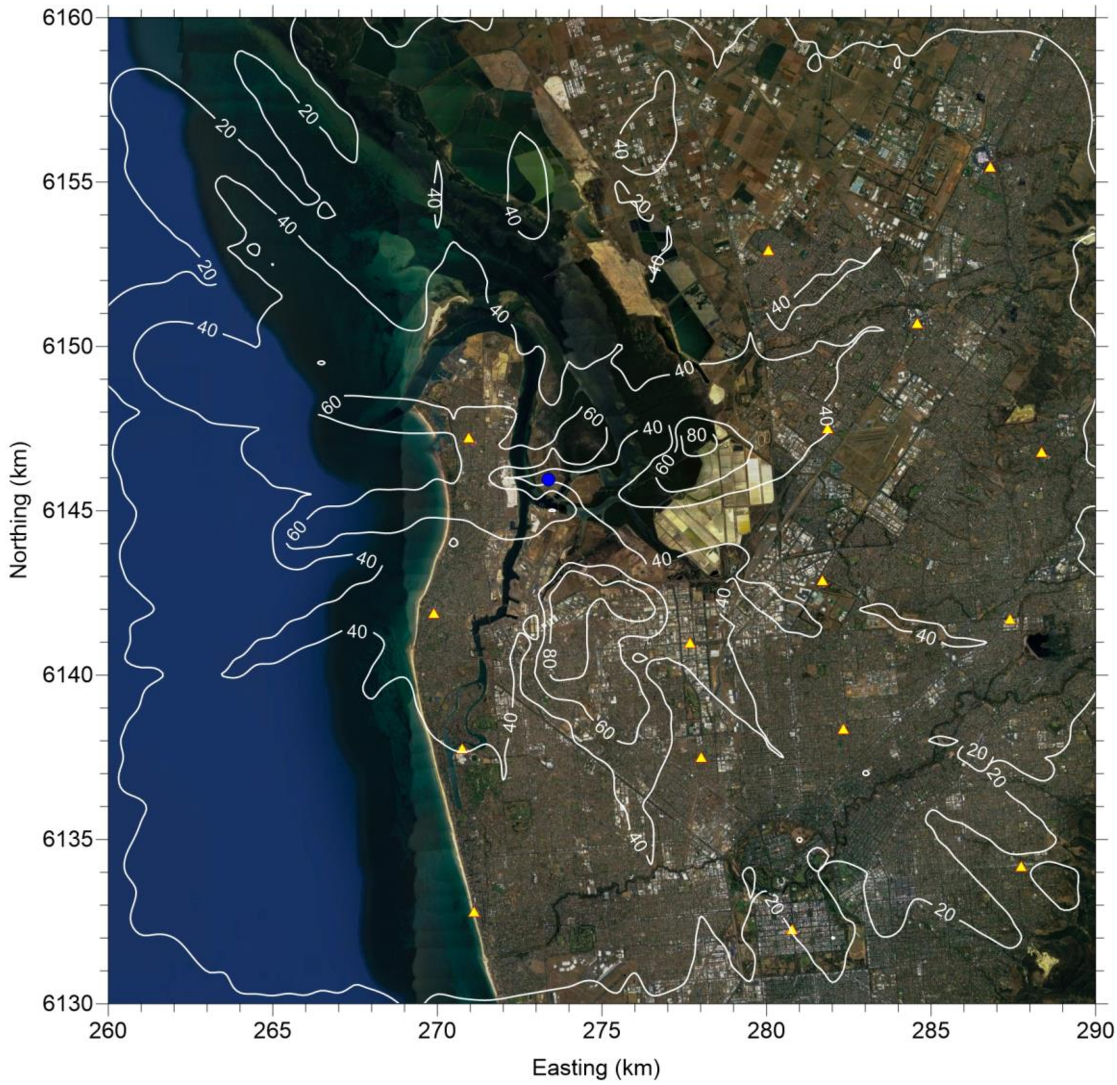


Figure 6-6: Stage 1, Project – Diesel Operation with TIPS B (typical load), incremental maximum 1 hour NO_2 (µg/m³)



MGA94, Zone 54H

Figure 6-7: Stage 1 + Stage 2, Project – Natural Gas Operation, with TIPS B (typical load), incremental maximum 1 hour NO_2 (µg/m³)

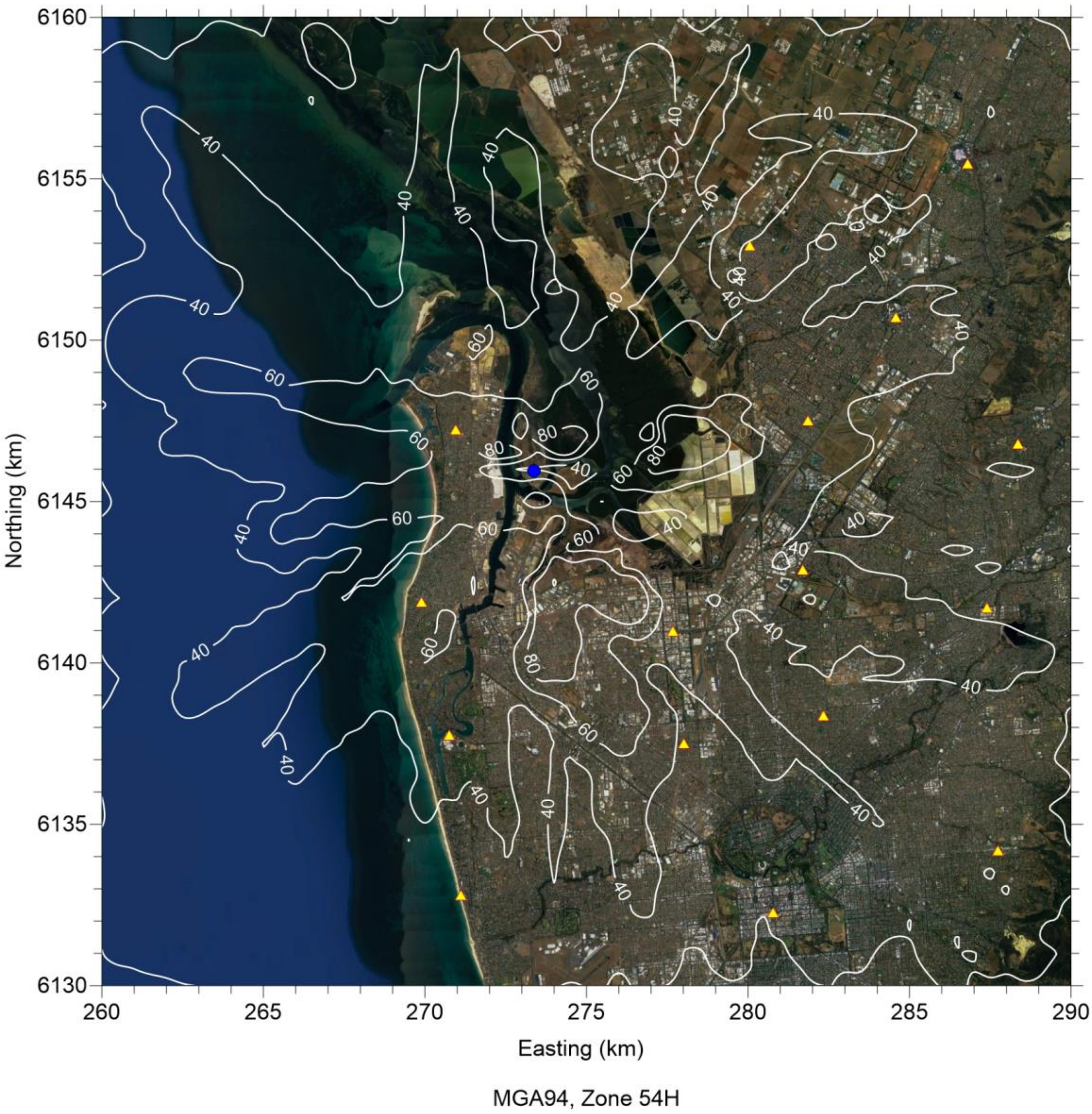


Figure 6-8: Stage 1 + Stage 2, Project – Diesel Operation with TIPS B (typical load), incremental maximum 1 hour NO_2 (µg/m³)

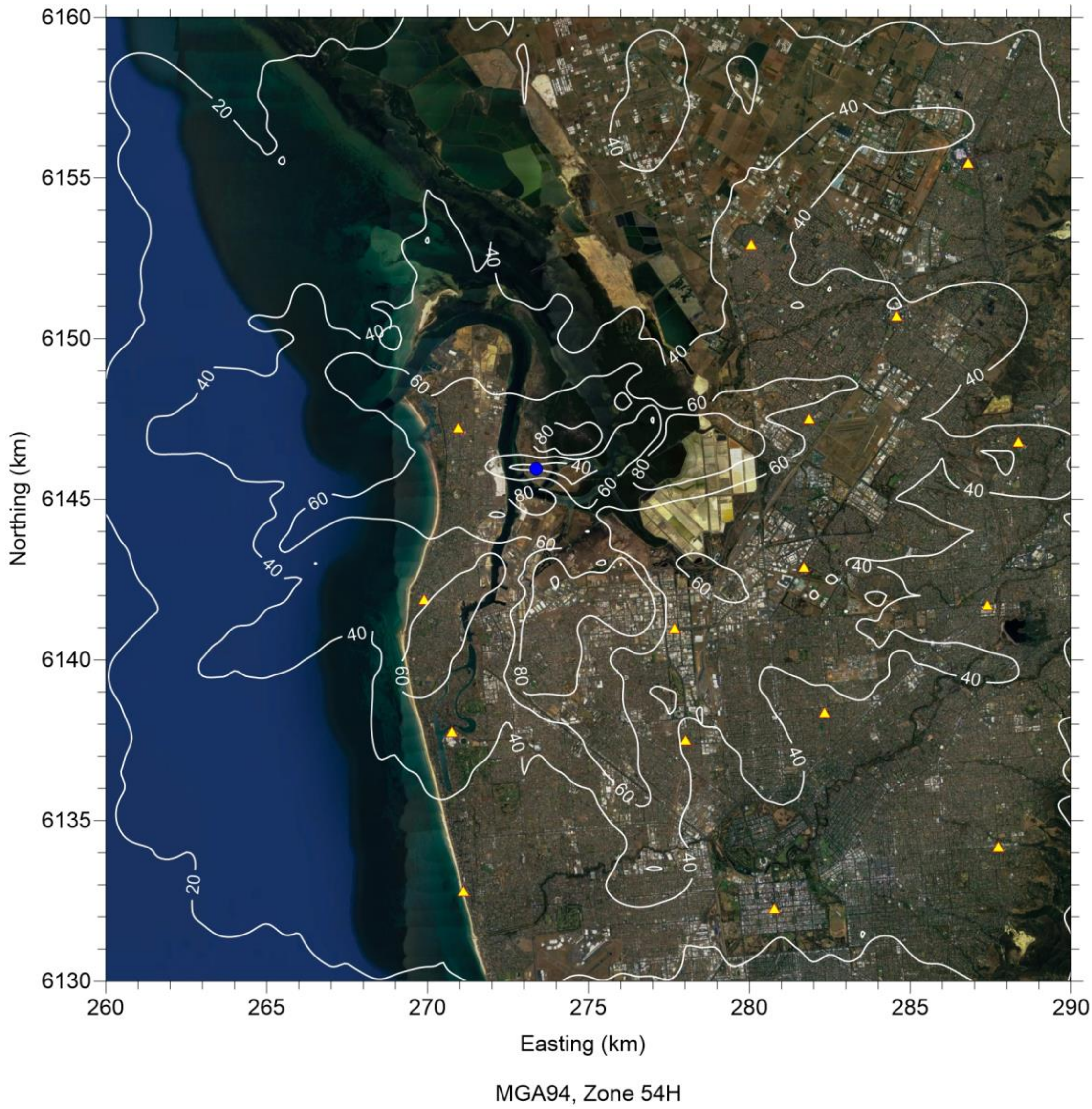


Figure 6-9: Stage 1, Project – Natural Gas Operation, with TIPS B (maximum load), incremental maximum 1 hour NO_2 (µg/m³)

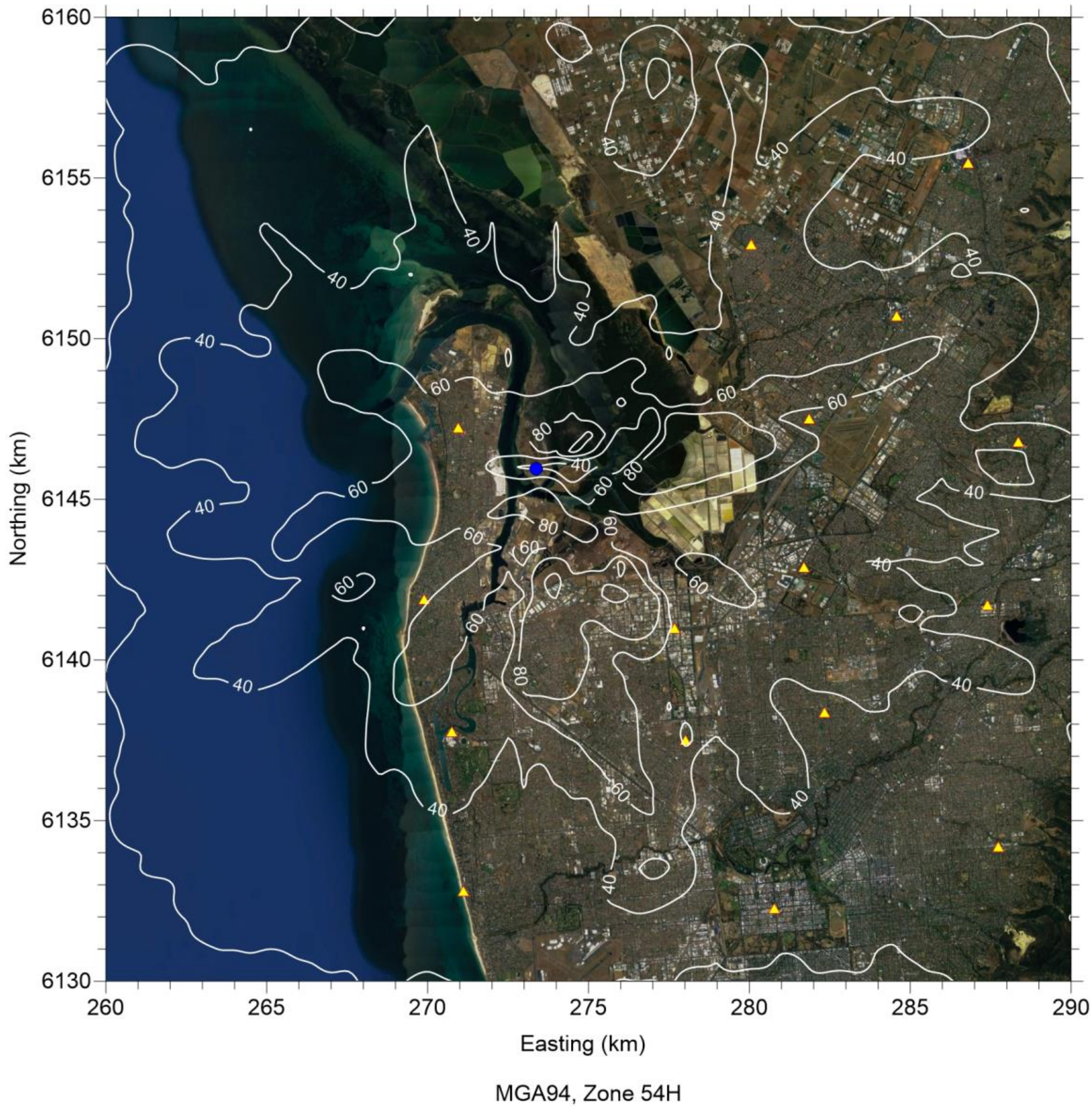


Figure 6-10: Stage 1, Project – Diesel Operation with TIPS B (maximum load), incremental maximum 1 hour NO_2 (µg/m³)

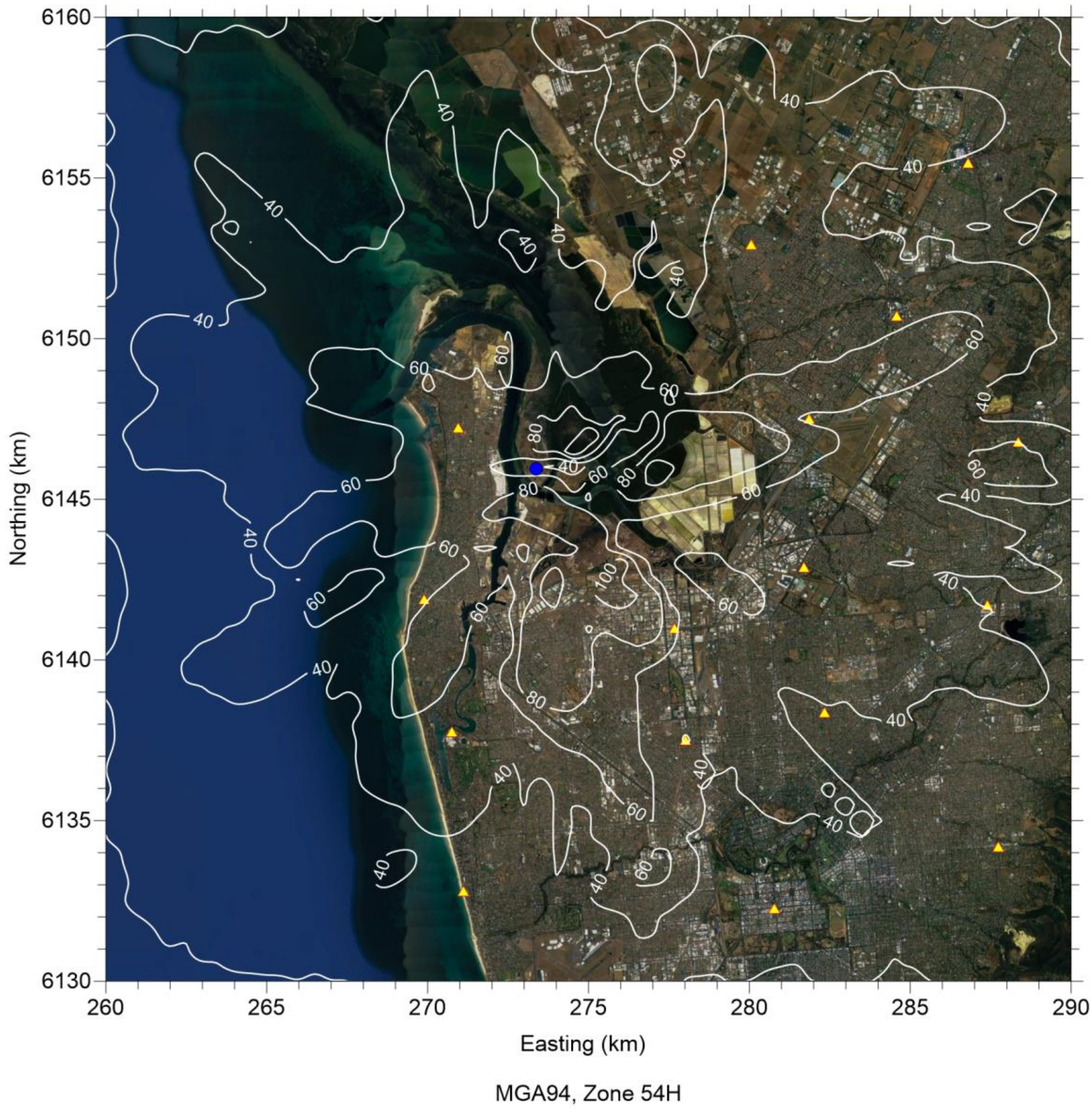


Figure 6-11: Stage 1 + Stage 2, Project – Natural Gas Operation, with TIPS B (maximum load), incremental maximum 1 hour NO_2 (µg/m³)

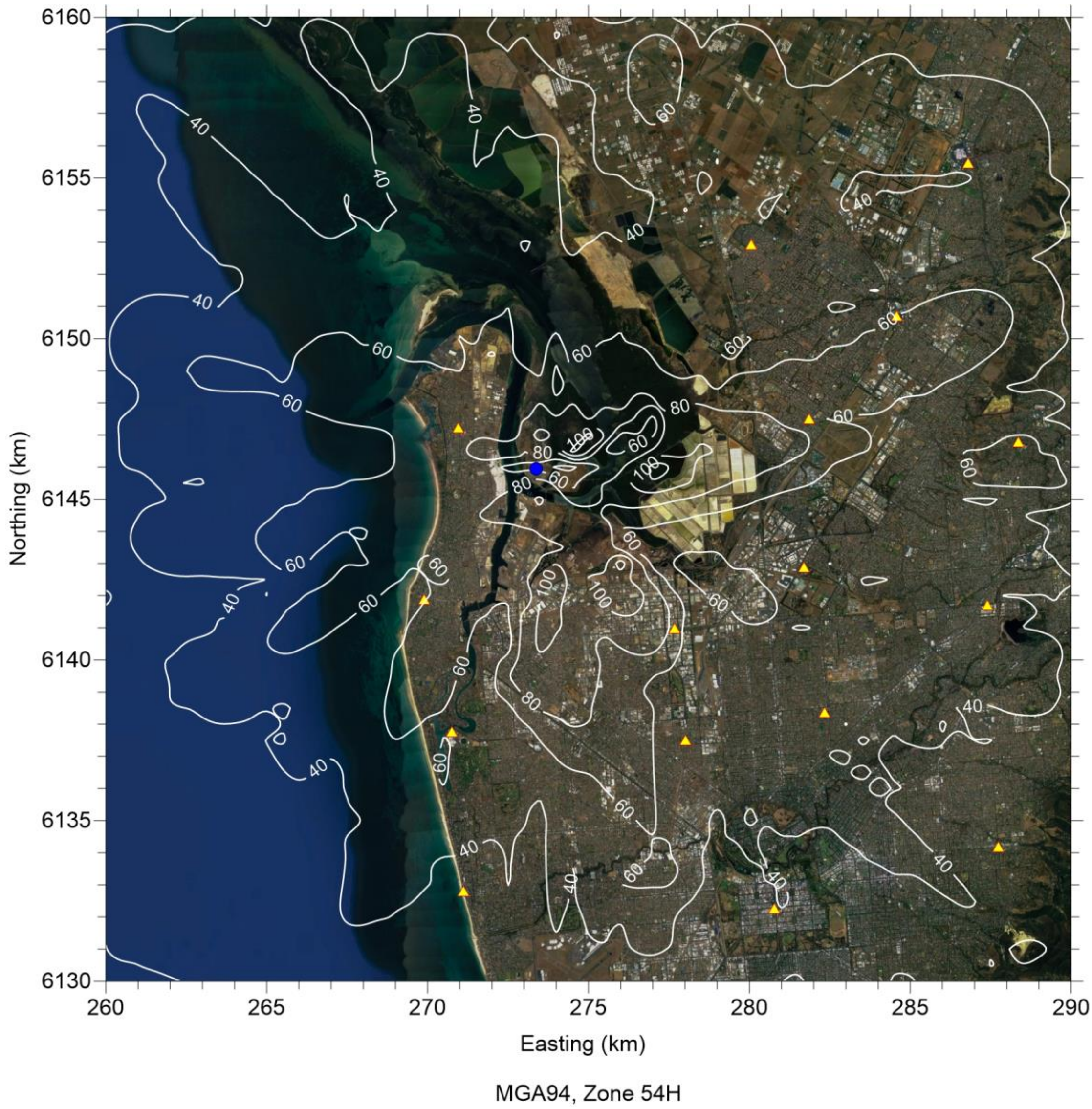


Figure 6-12: Stage 1 + Stage 2, Project – Diesel Operation with TIPS B (maximum load), incremental maximum 1 hour NO_2 (µg/m³)

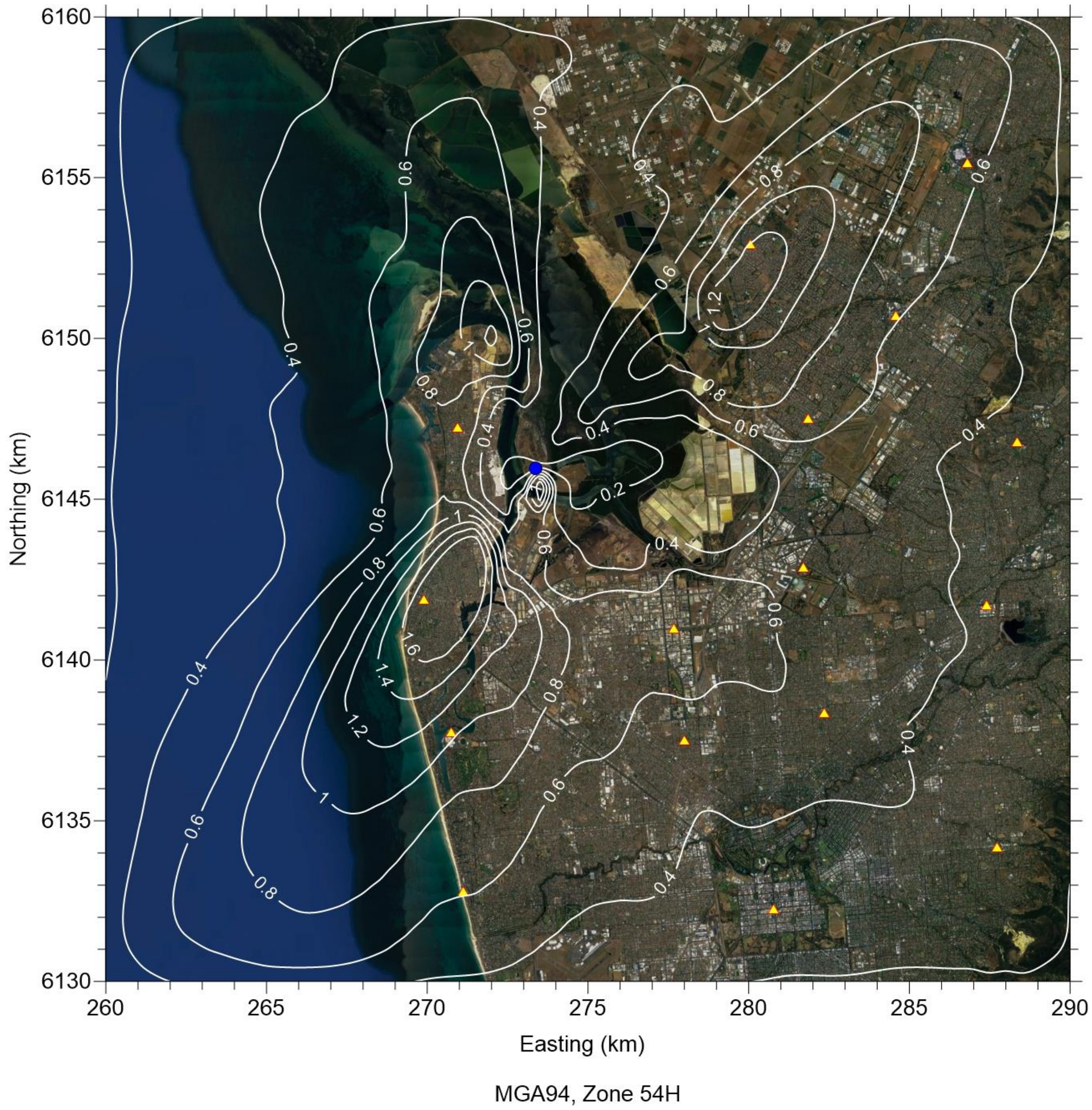


Figure 6-13: Stage 1 + Stage 2, Project – Natural Gas Operation with TIPS B (maximum load), incremental annual average NO_2 (µg/m³)

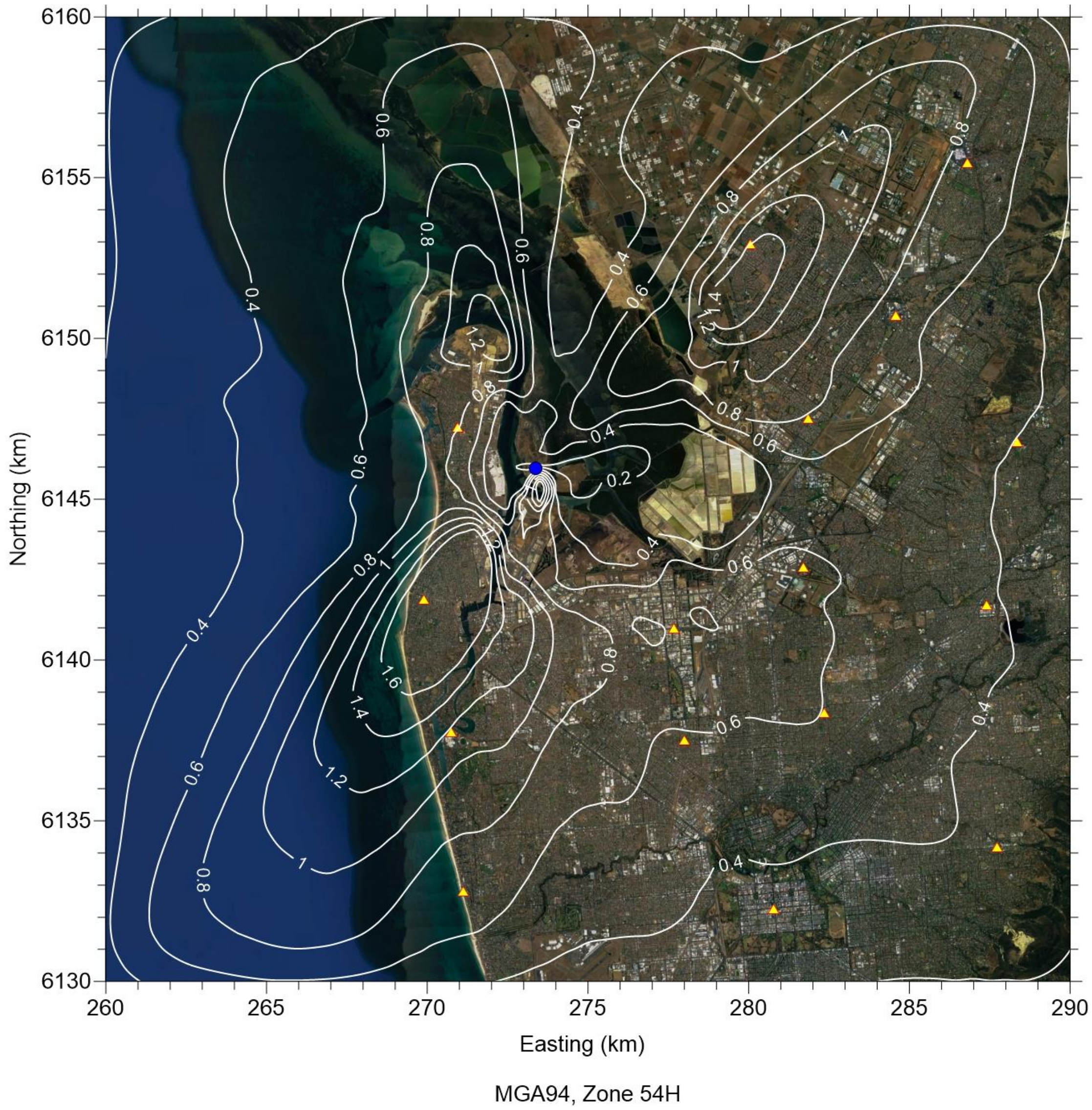


Figure 6-14: Stage 1 + Stage 2, Project – Diesel Operation with TIPS B (maximum load), incremental annual average NO_2 (µg/m³)

6.1.3 $PM_{2.5}$ contour isopleths

Maximum 24 hour, and annual average $PM_{2.5}$ contour isopleths have been provided for Stage 1 + Stage 2 operations (Natural Gas and Diesel), with TIPS B at maximum load.

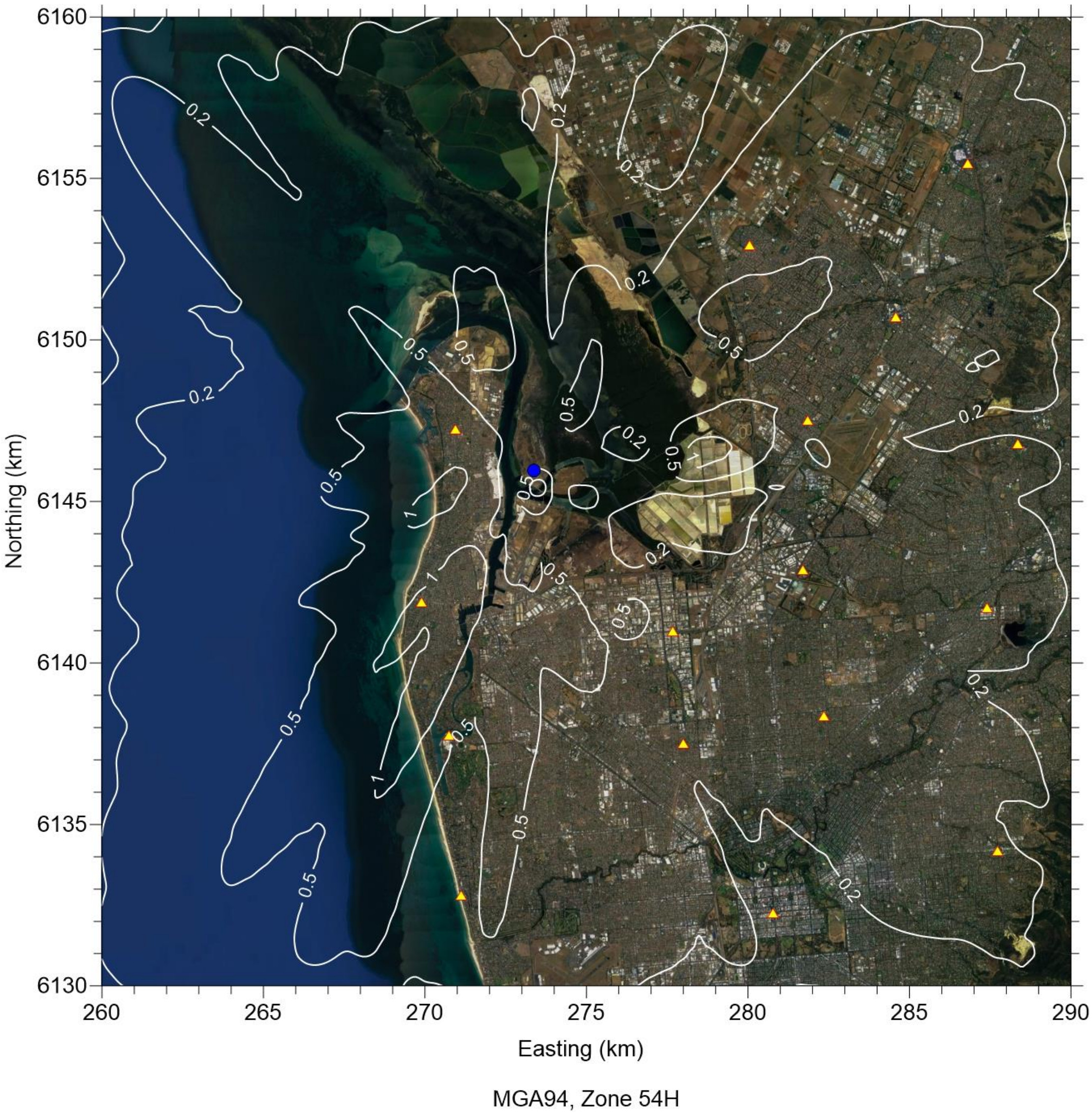


Figure 6-15: Stage 1 + Stage 2 Project – Natural Gas Operation with TIPS B (maximum load), incremental maximum 24 hour $PM_{2.5}$ (µg/m³)

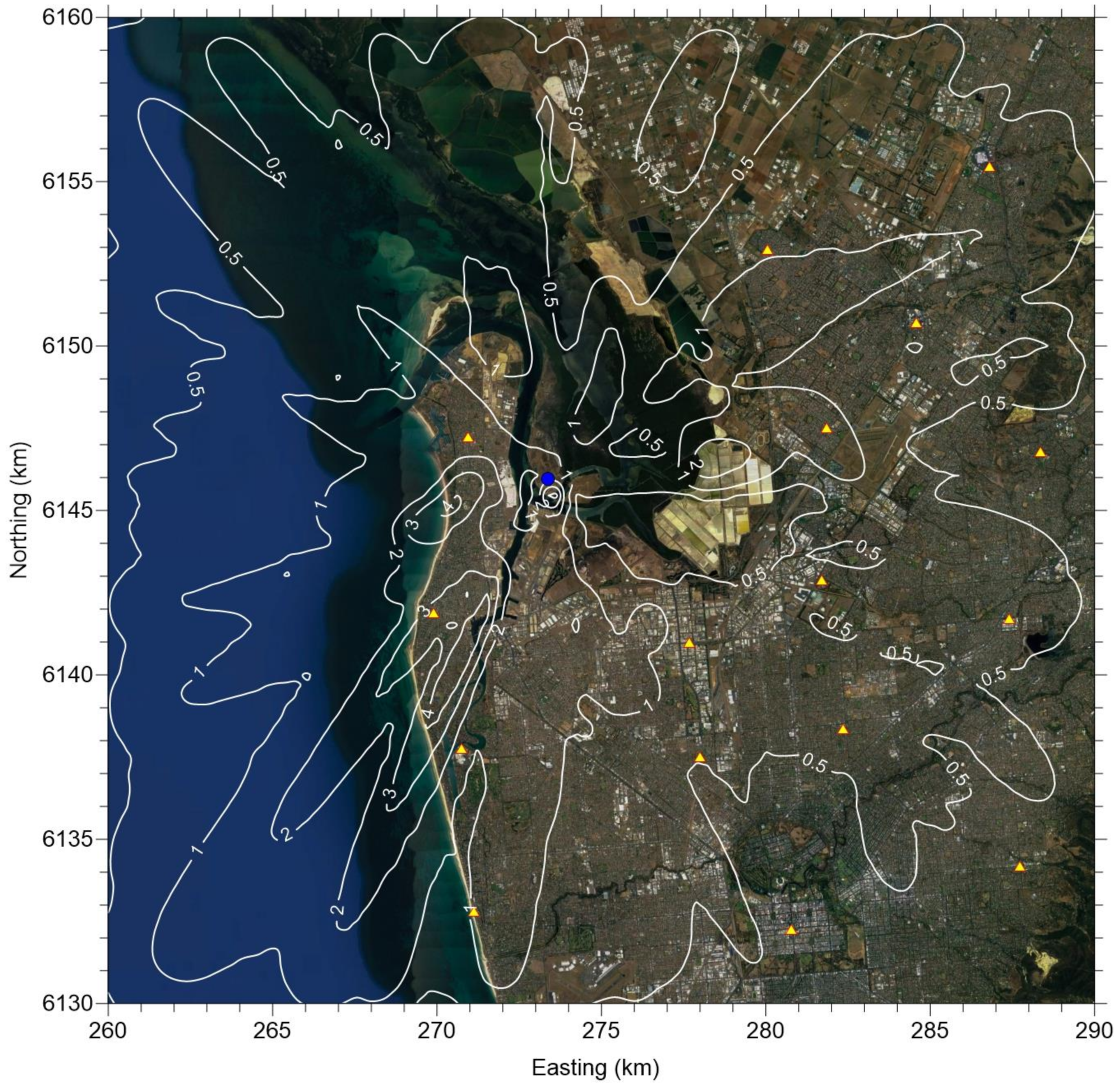


Figure 6-16: Stage 1 + Stage 2 Project – Diesel Operation with TIPS B (maximum load), incremental maximum 24 hour $PM_{2.5}$ (µg/m³)

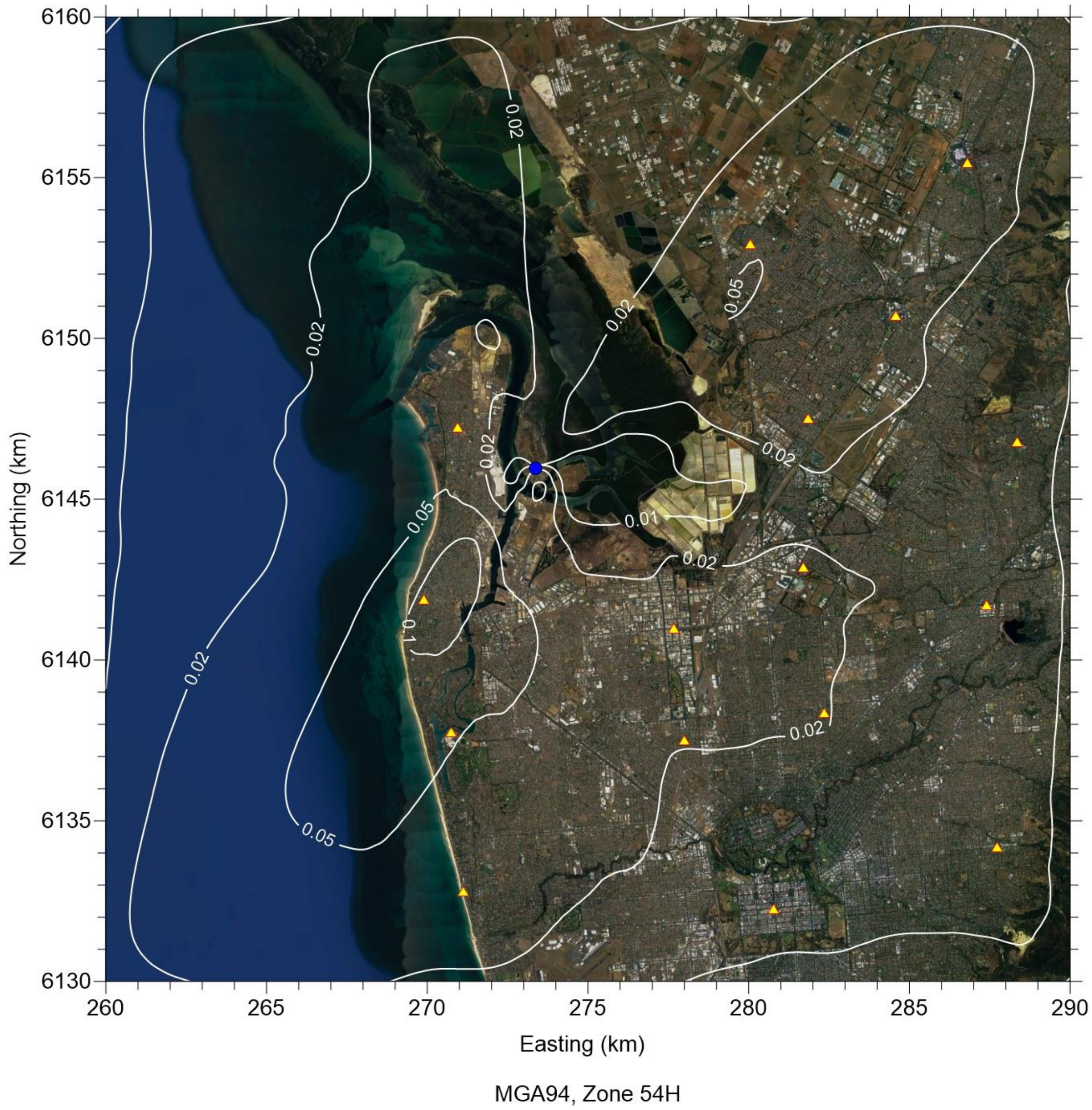


Figure 6-17: Stage 1 + Stage 2 Project – Natural Gas Operation with TIPS B (maximum load), incremental maximum annual average $PM_{2.5}$ (µg/m³)

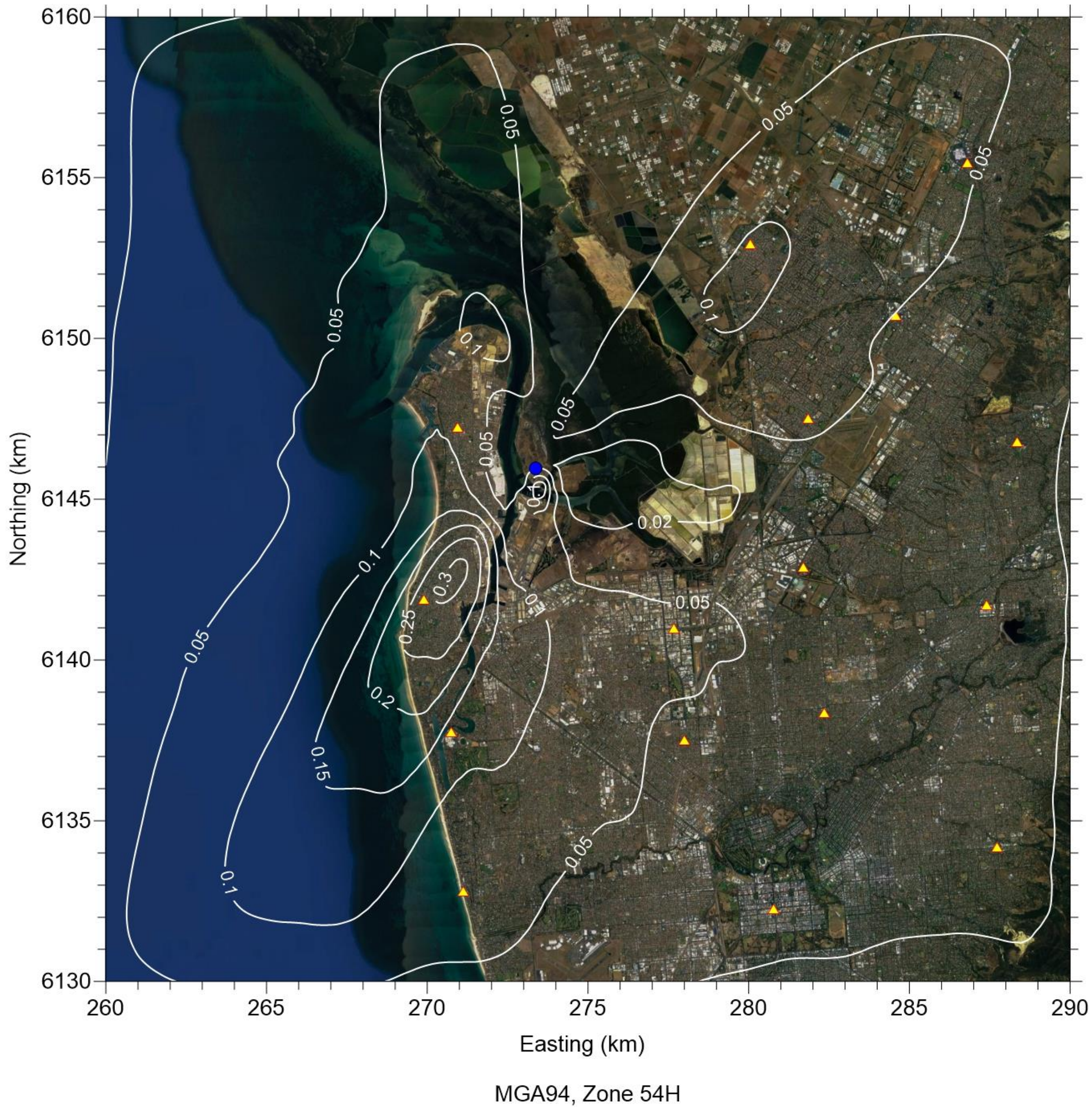


Figure 6-18: Stage 1 + Stage 2 Project – Diesel Operation with TIPS B (maximum load), incremental maximum annual average $PM_{2.5}$ (µg/m³)

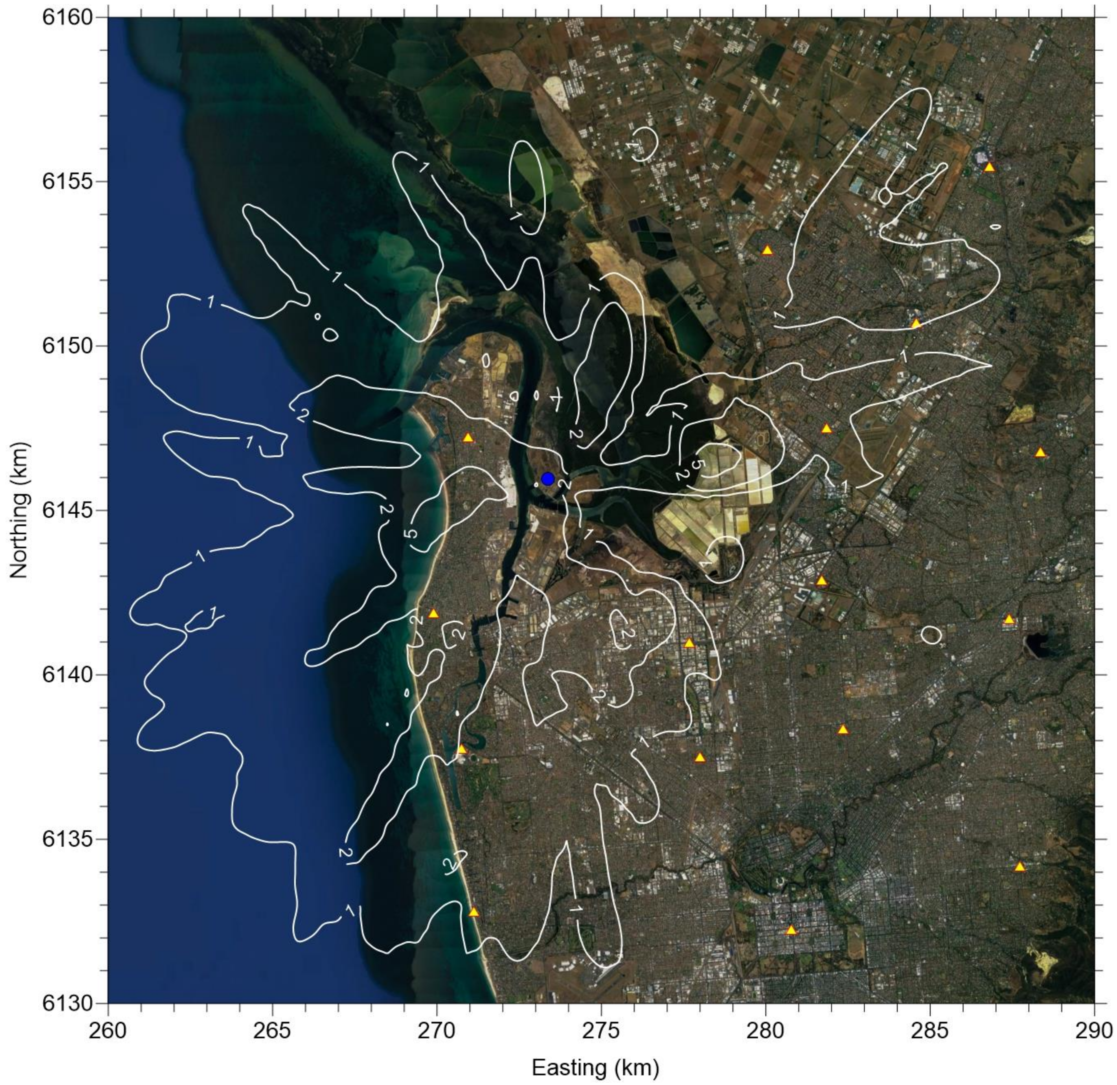
6.2 PM_{10} SO_2 and CO

Table 6-4 presents a summary of the results of PM_{10}, SO_2 and CO modelling, with assessment against relevant impact assessment criteria.

Corresponding contour isopleths have been provided for Stage 1 + Stage 2 operations (Natural Gas and Diesel), with TIPS B at maximum load. It is noted that $PM_{2.5}$ and PM_{10} results are identical given that all PM_{10} will fall into the $PM_{2.5}$ particle fraction. Accordingly, incremental $PM_{2.5}$ results are identical to PM_{10} results, and the corresponding $PM_{2.5}$ contour plots should be interrogated for an understanding of the spatial variation of PM_{10} model predictions.

Table 6-4: PM_{10}, SO_2 and CO modelling, with assessment against relevant criteria

Receptor	PM_{10} 24-hour	SO_2 1-hour	SO_2 24-hour	SO_2 Annual	CO 1-hour	CO 8-hour
Natural Gas						
Adelaide	0.2	0.6	0.0	0.00	30	7
Broadview	0.3	0.5	0.1	0.01	26	7
Burton	0.4	0.6	0.1	0.01	27	11
Croydon Park	0.2	0.7	0.1	0.01	34	8
Elizabeth	0.3	0.6	0.1	0.01	33	14
Henley Beach	0.4	1.3	0.1	0.01	68	20
Holden Hill	0.3	0.6	0.1	0.00	33	10
Magill	0.2	0.5	0.1	0.00	23	8
North Haven	0.8	2.5	0.2	0.01	139	20
Parafield Gardens	0.5	1.3	0.2	0.01	69	21
Pooraka	0.3	0.6	0.1	0.01	32	10
Salisbury	0.4	1.1	0.1	0.01	58	9
Semaphore	1.2	2.3	0.6	0.04	125	71
West Lakes	0.6	1.9	0.2	0.02	105	20
Wingfield	0.4	1.4	0.1	0.01	67	9
Wynn Vale	0.2	0.5	0.1	0.00	27	7
Grid Maximum	1.7	9.5	0.8	0.04	517	120
Diesel						
Adelaide	0.4	0.1	0.0	0.00	12	3
Broadview	0.7	0.1	0.0	0.00	10	3
Burton	0.9	0.2	0.0	0.00	12	4
Croydon Park	0.5	0.2	0.0	0.00	15	3
Elizabeth	0.7	0.1	0.0	0.00	12	5
Henley Beach	1.1	0.2	0.0	0.00	26	8
Holden Hill	0.6	0.1	0.0	0.00	12	4
Magill	0.4	0.1	0.0	0.00	9	3
North Haven	1.4	0.4	0.0	0.00	52	9
Parafield Gardens	1.4	0.2	0.0	0.00	29	9
Pooraka	0.7	0.1	0.0	0.00	13	4
Salisbury	0.8	0.1	0.0	0.00	23	3
Semaphore	3.9	0.3	0.1	0.01	45	26
West Lakes	1.5	0.2	0.0	0.00	38	7
Wingfield	0.8	0.3	0.0	0.00	29	4
Wynn Vale	0.4	0.2	0.0	0.00	11	3
Grid Maximum	5.7	1.4	0.1	0.01	191	44
Assessment						
Background	21	59	5	0.2	35	39
Maximum Incremental	5.7	9.5	0.8	0.0	517	120
Maximum Cumulative	26.7	68.5	5.8	0.2	552	159
Criterion	50	570	230	60	31240	11250



MGA94, Zone 54H

Figure 6-19: Stage 1 + Stage 2 Project – Natural Gas Operation with TIPS B (maximum load), incremental maximum 1 hour SO_2 (µg/m³)

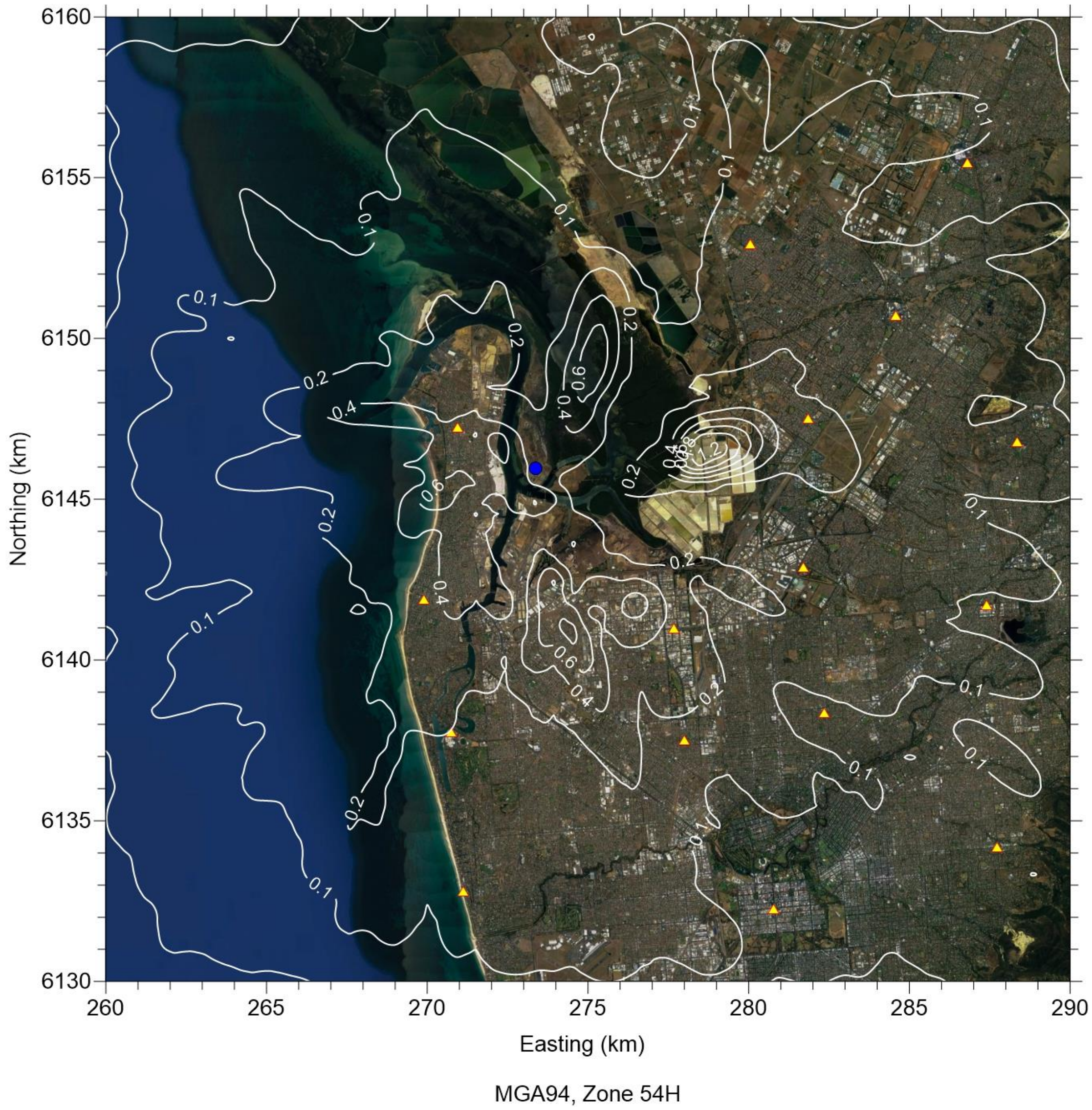
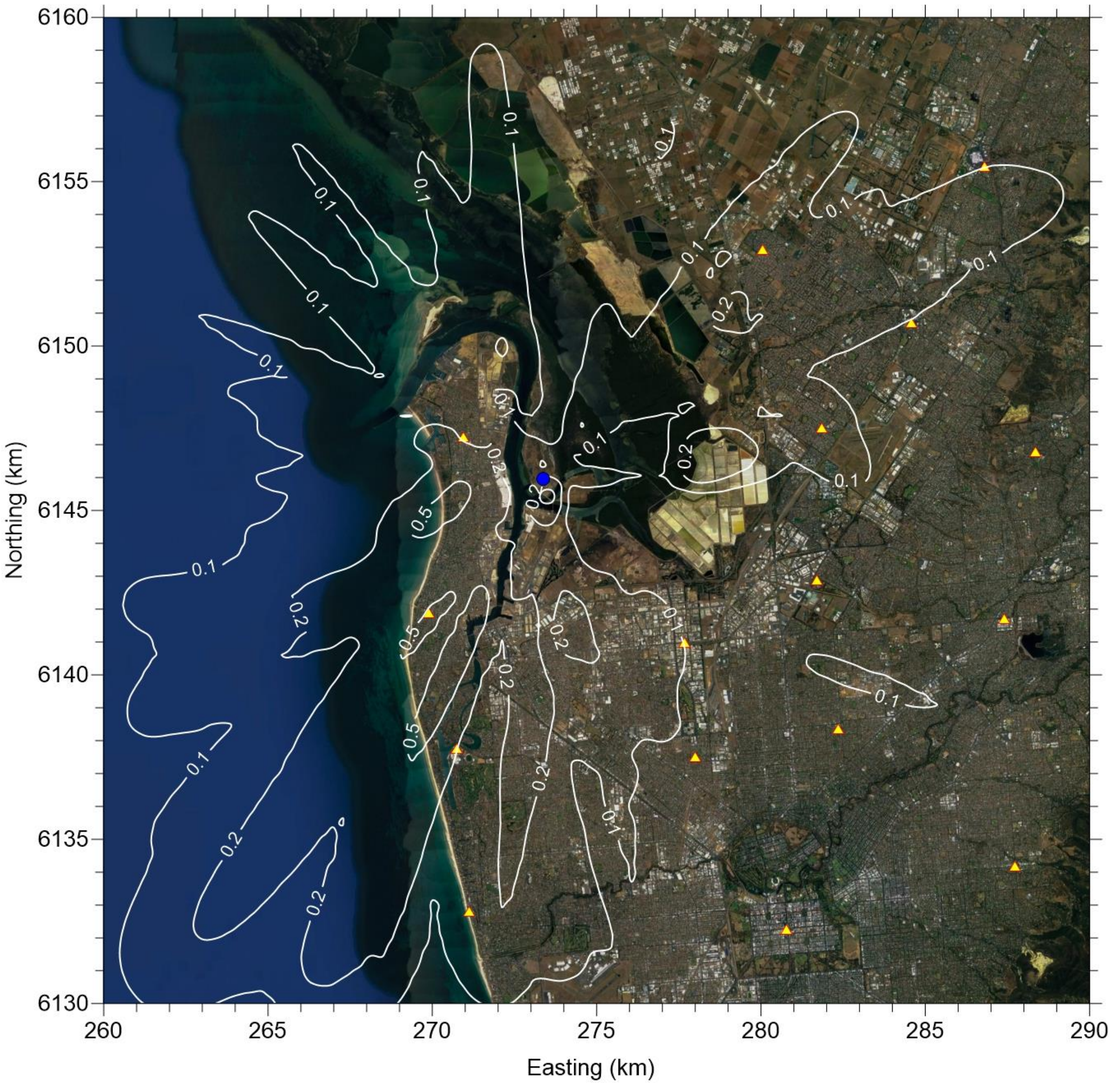


Figure 6-20: Stage 1 + Stage 2 Project – Diesel Operation with TIPS B (maximum load), incremental maximum 1 hour SO_2 (µg/m³)



MGA94, Zone 54H

Figure 6-21: Stage 1 + Stage 2 Project – Natural Gas Operation with TIPS B (maximum load), incremental maximum 24 hour SO_2 (µg/m³)

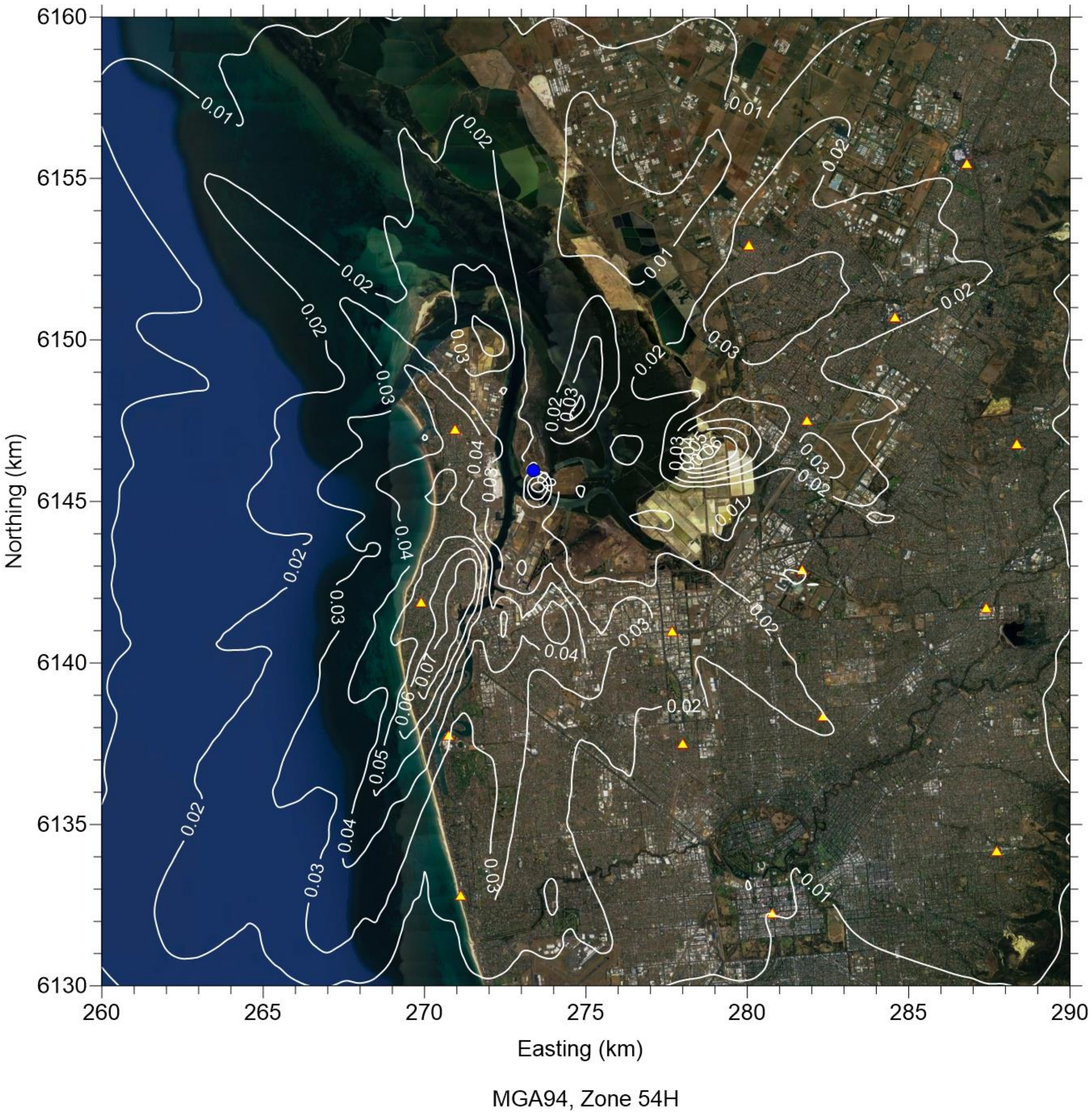


Figure 6-22: Stage 1 + Stage 2 Project – Diesel Operation with TIPS B (maximum load), incremental maximum 24 hour SO_2 (µg/m³)

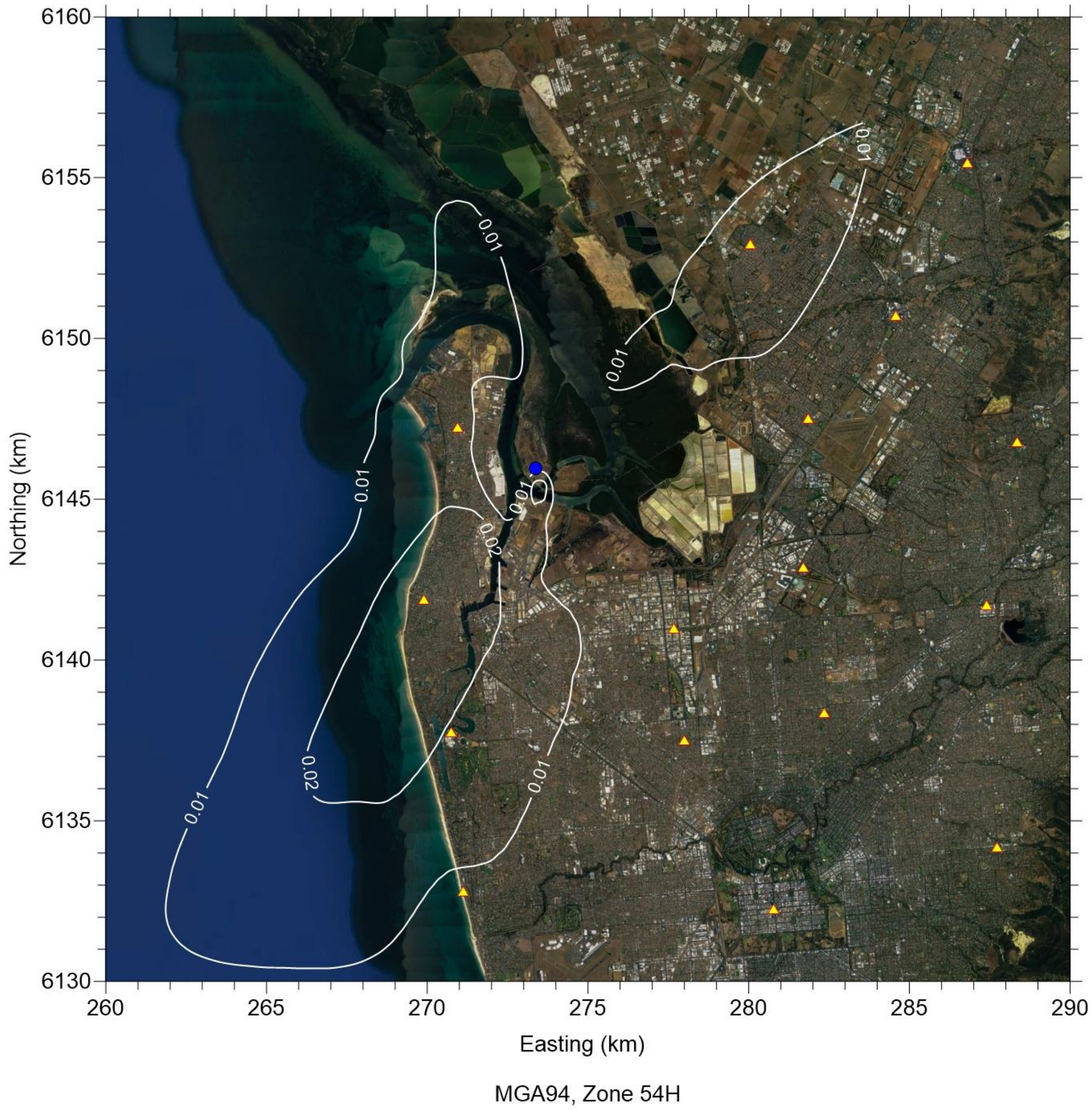


Figure 6-23: Stage 1 + Stage 2 Project – Natural Gas Operation with TIPS B (maximum load), incremental annual average SO_2 (µg/m³)

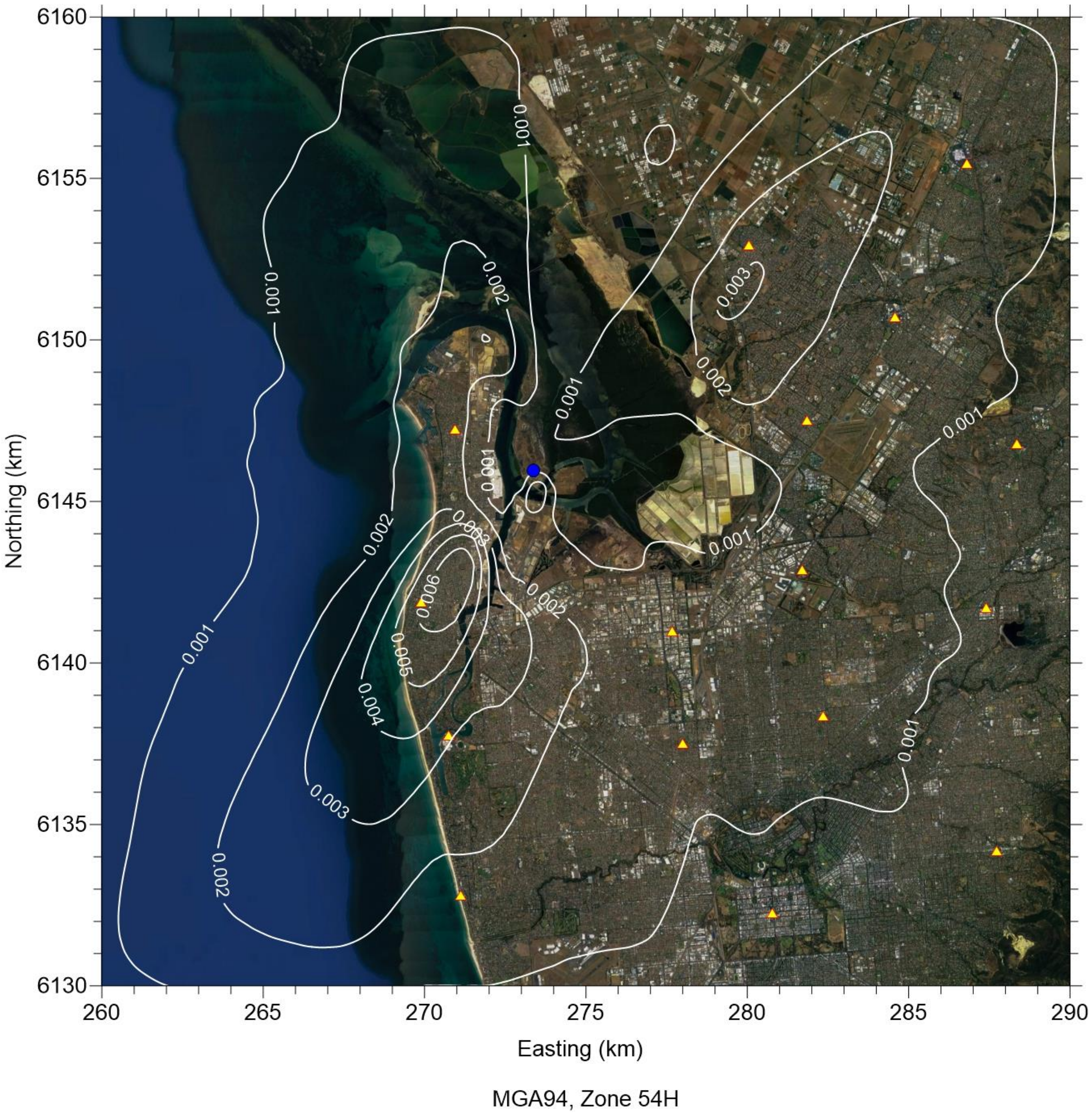


Figure 6-24: Stage 1 + Stage 2 Project – Diesel Operation with TIPS B (maximum load), incremental annual average SO_2 (µg/m³)

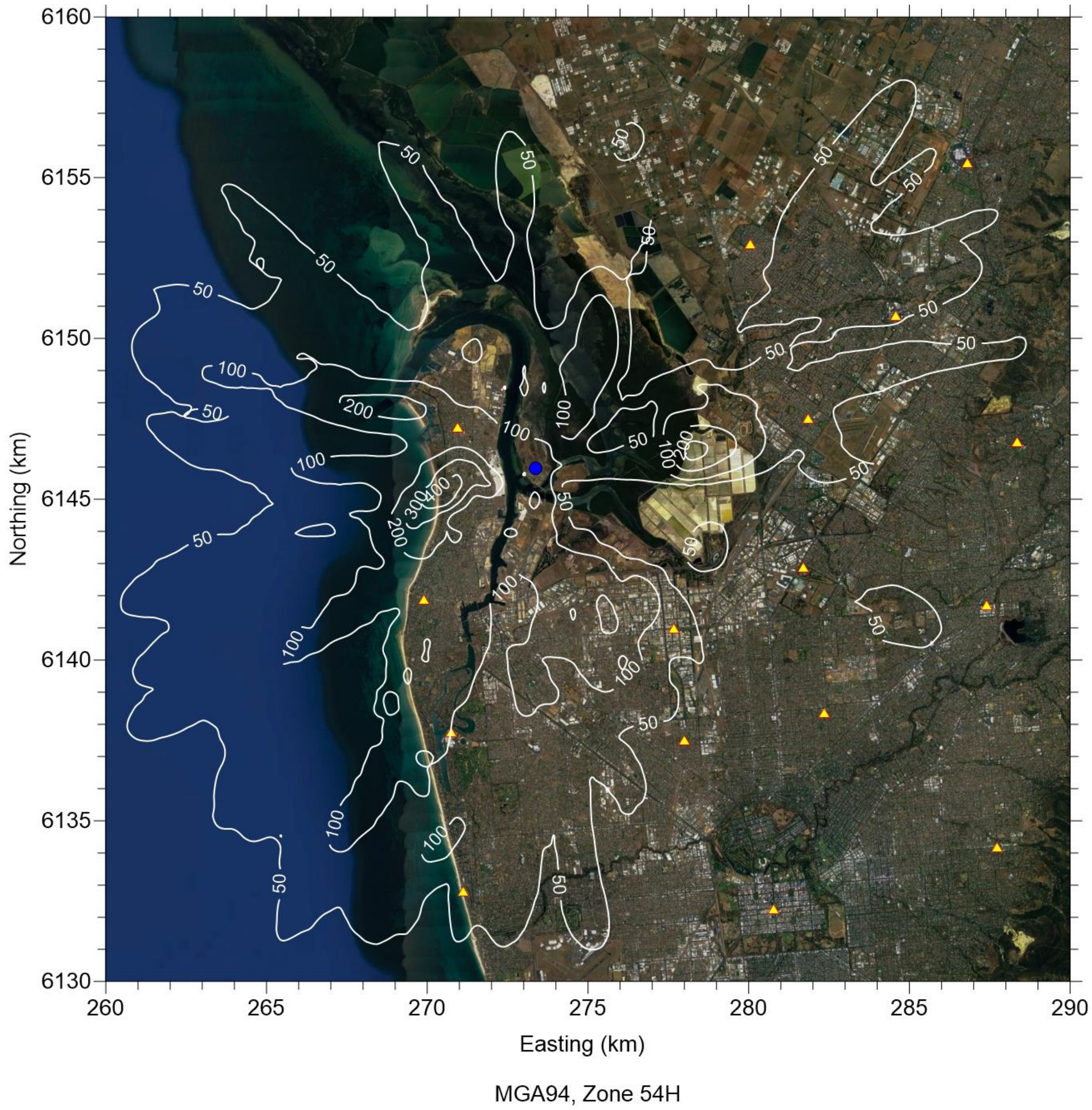


Figure 6-25: Stage 1 + Stage 2 Project – Natural Gas Operation with TIPS B (maximum load), incremental maximum 1 hour CO (µg/m³)

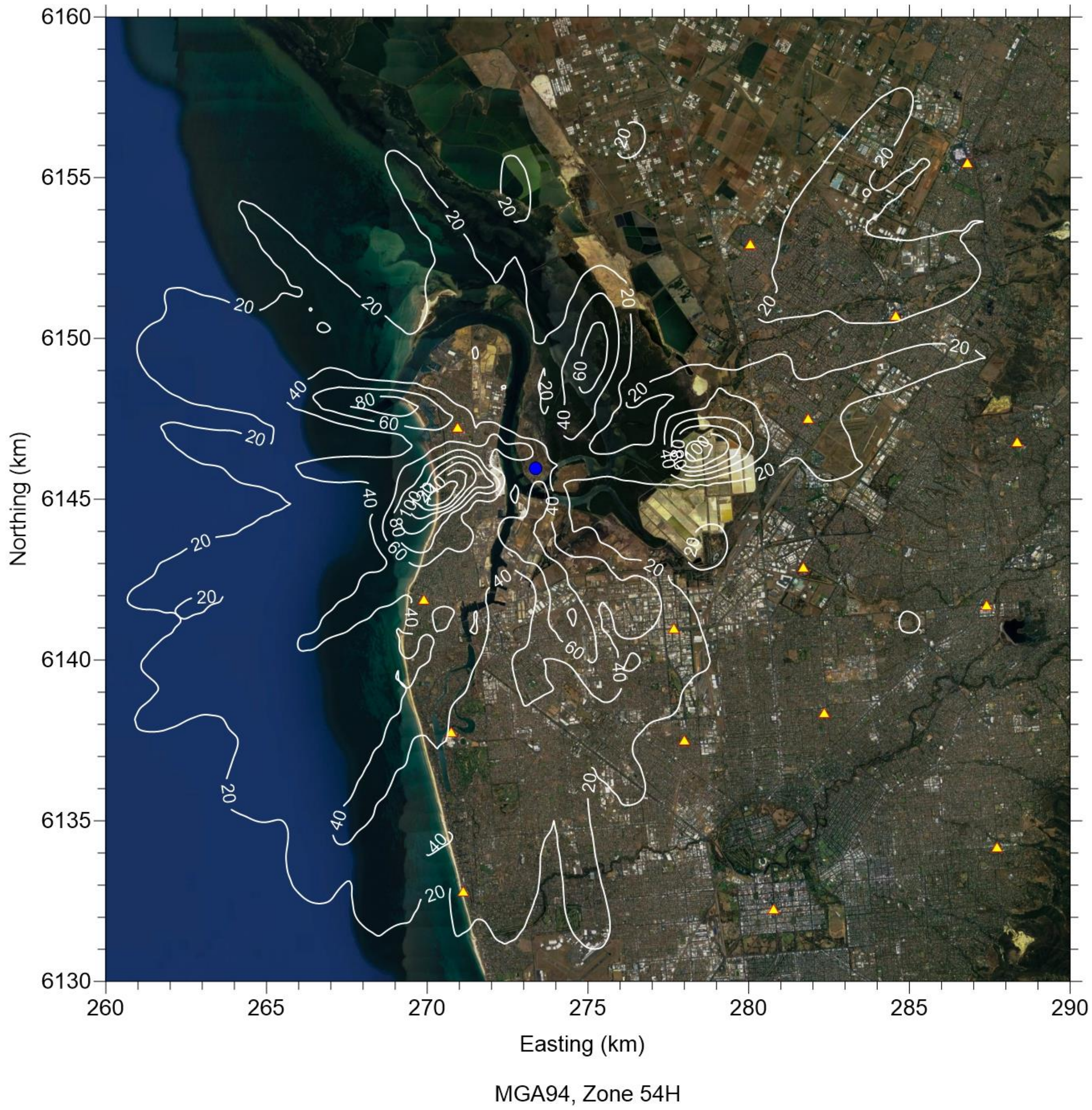


Figure 6-26: Stage 1 + Stage 2 Project – Diesel Operation with TIPS B (maximum load), incremental maximum 1 hour CO (µg/m³)

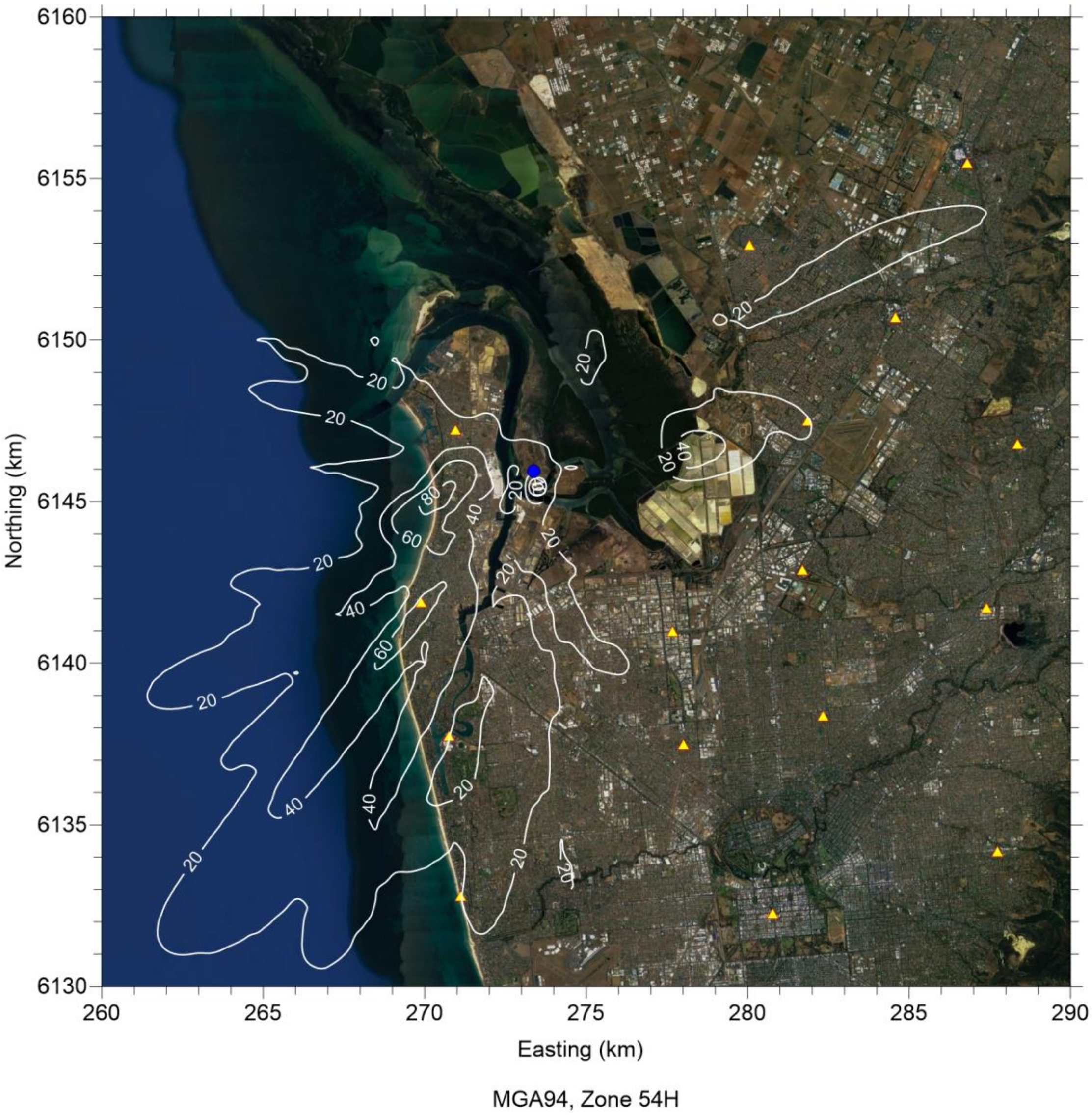


Figure 6-27: Stage 1 + Stage 2 Project – Natural Gas Operation with TIPS B (maximum load), incremental maximum 8 hour CO (µg/m³)

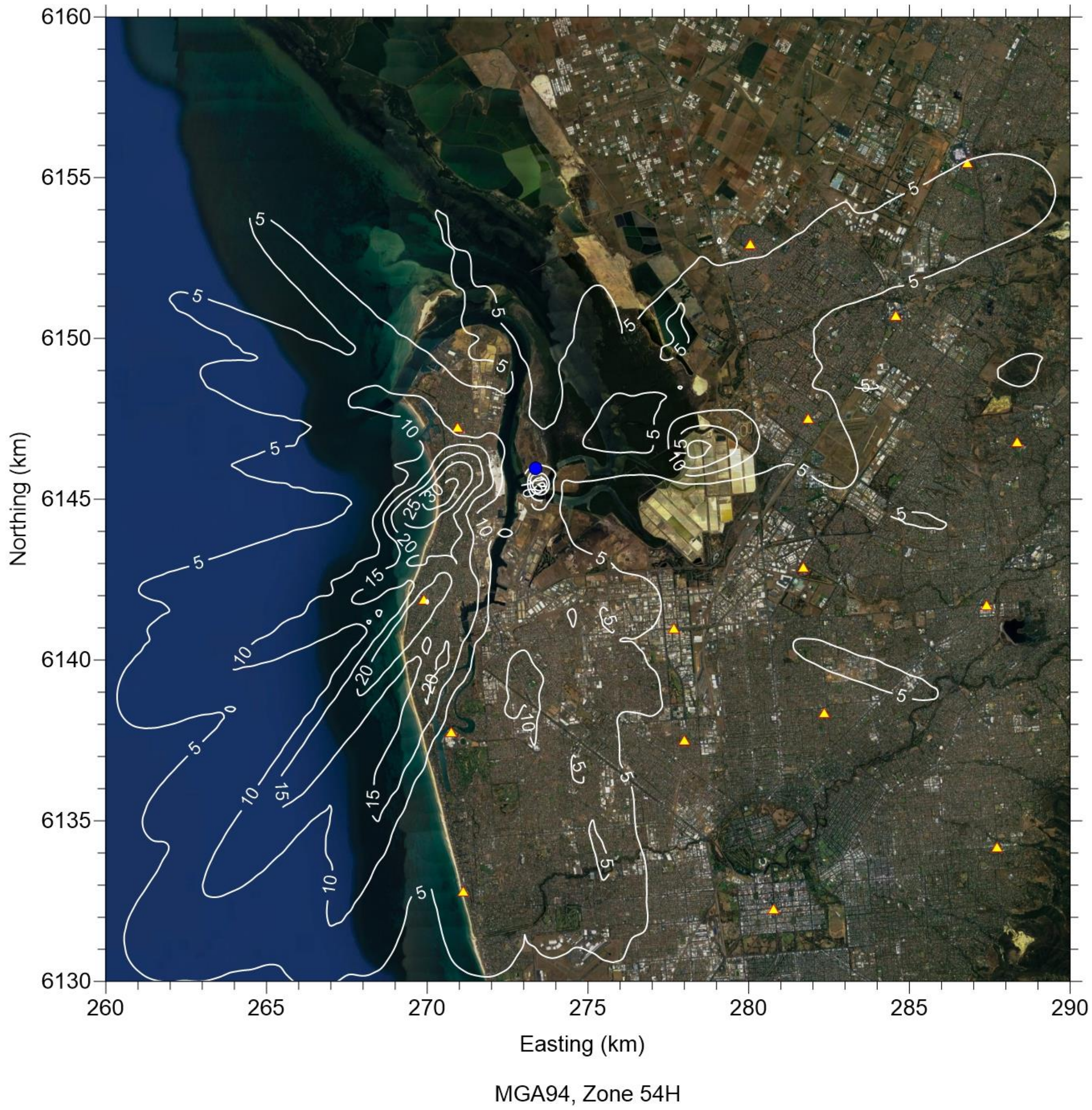


Figure 6-28: Stage 1 + Stage 2 Project – Diesel Operation with TIPS B (maximum load), incremental maximum 8 hour CO (µg/m³)

6.3 Formaldehyde, Benzene and PAHs

Table 6-5 presents a summary of the results of formaldehyde, benzene and PAH modelling for Stage 1 + Stage 2 operations (Natural Gas and Diesel), with TIPS B at maximum load. As shown in Table 6-5, results are generally low, with formaldehyde emissions from natural gas operation of most significance, comprising approximately 45% of criterion. Both benzene and PAHs were less than 1% their respective annual average criteria. On this basis contour plots have been limited to 3 minute averaging periods.

Table 6-5: Summary of benzene, formaldehyde and PAHs modelling, with assessment against relevant criteria (µg/m³) - Stage 1 + Stage 2 Project with TIPS B (maximum load)

Receptor	Benzene 3-minute	Benzene Annual	Formaldehyde 3-minute	PAHs* 3-minute	PAHs* Annual
Natural Gas					
Adelaide	0.3	0.001	1.1	0.0001	0.000001
Broadview	0.2	0.001	1.0	0.0002	0.000001
Burton	0.3	0.004	1.1	0.0003	0.000002
Croydon Park	0.3	0.001	1.3	0.0003	0.000001
Elizabeth	0.3	0.002	1.3	0.0001	0.000001
Henley Beach	0.6	0.002	2.6	0.0002	0.000001
Holden Hill	0.3	0.001	1.3	0.0002	0.000001
Magill	0.2	0.001	0.9	0.0001	0.000001
North Haven	1.3	0.003	5.4	0.0007	0.000002
Parafield Gardens	0.7	0.002	2.7	0.0004	0.000001
Pooraka	0.3	0.001	1.3	0.0002	0.000001
Salisbury	0.6	0.002	2.2	0.0002	0.000001
Semaphore	1.2	0.011	4.8	0.0005	0.000004
West Lakes	1.0	0.005	4.0	0.0003	0.000002
Wingfield	0.6	0.002	2.4	0.0005	0.000002
Wynn Vale	0.2	0.001	1.0	0.0003	0.000001
Grid Maximum	5.0	0.012	20.0	0.0022	0.000004
Diesel					
Adelaide	0.1	0.000	<0.1	0.0003	0.000001
Broadview	0.1	0.001	<0.1	0.0002	0.000002
Burton	0.1	0.001	<0.1	0.0004	0.000004
Croydon Park	0.1	0.001	<0.1	0.0005	0.000002
Elizabeth	0.1	0.001	<0.1	0.0002	0.000002
Henley Beach	0.3	0.001	<0.1	0.0005	0.000003
Holden Hill	0.1	0.000	<0.1	0.0003	0.000001
Magill	0.1	0.000	<0.1	0.0003	0.000001
North Haven	0.6	0.001	0.1	0.0012	0.000004
Parafield Gardens	0.3	0.001	0.1	0.0007	0.000003
Pooraka	0.1	0.001	<0.1	0.0004	0.000002
Salisbury	0.2	0.001	<0.1	0.0004	0.000002
Semaphore	0.5	0.004	0.1	0.0009	0.000011
West Lakes	0.4	0.002	<0.1	0.0007	0.000005
Wingfield	0.2	0.001	0.1	0.0009	0.000003
Wynn Vale	0.1	0.000	<0.1	0.0004	0.000001
Grid Maximum	2.1	0.005	0.3	0.0040	0.000012
Assessment					
Maximum Incremental	5.0	0.012	20.0	0.004	0.00001
Criterion	58	10	44	0.8	0.003

Note: PAHs as benzo(a)pyrene equivalent.

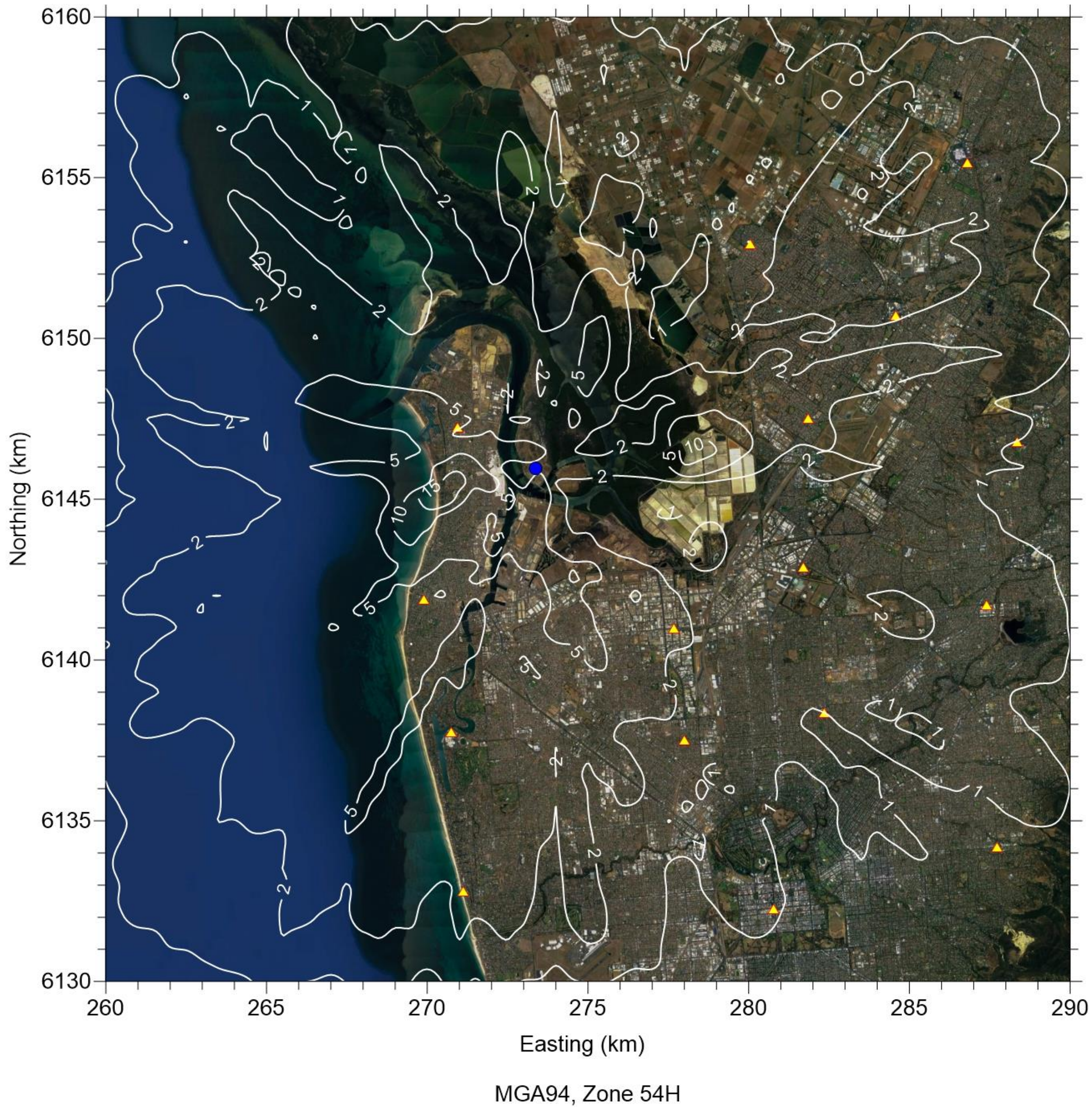


Figure 6-29: Stage 1 + Stage 2 Project – Natural Gas Operation with TIPS B (maximum load), incremental maximum 3 minute average formaldehyde (µg/m³)

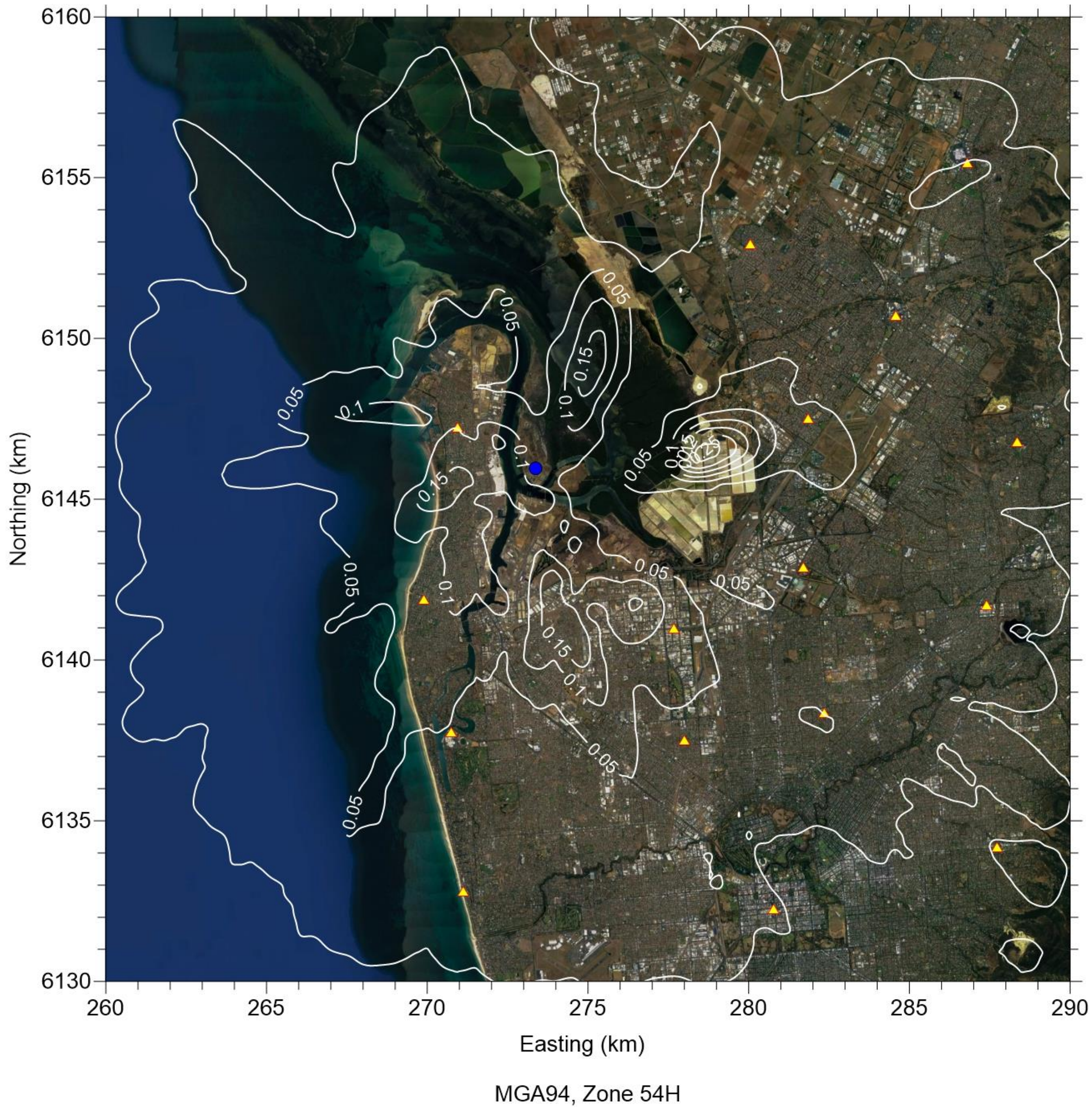


Figure 6-30: Stage 1 + Stage 2 Project – Diesel Operation with TIPS B (maximum load), incremental maximum 3 minute average formaldehyde (µg/m³)

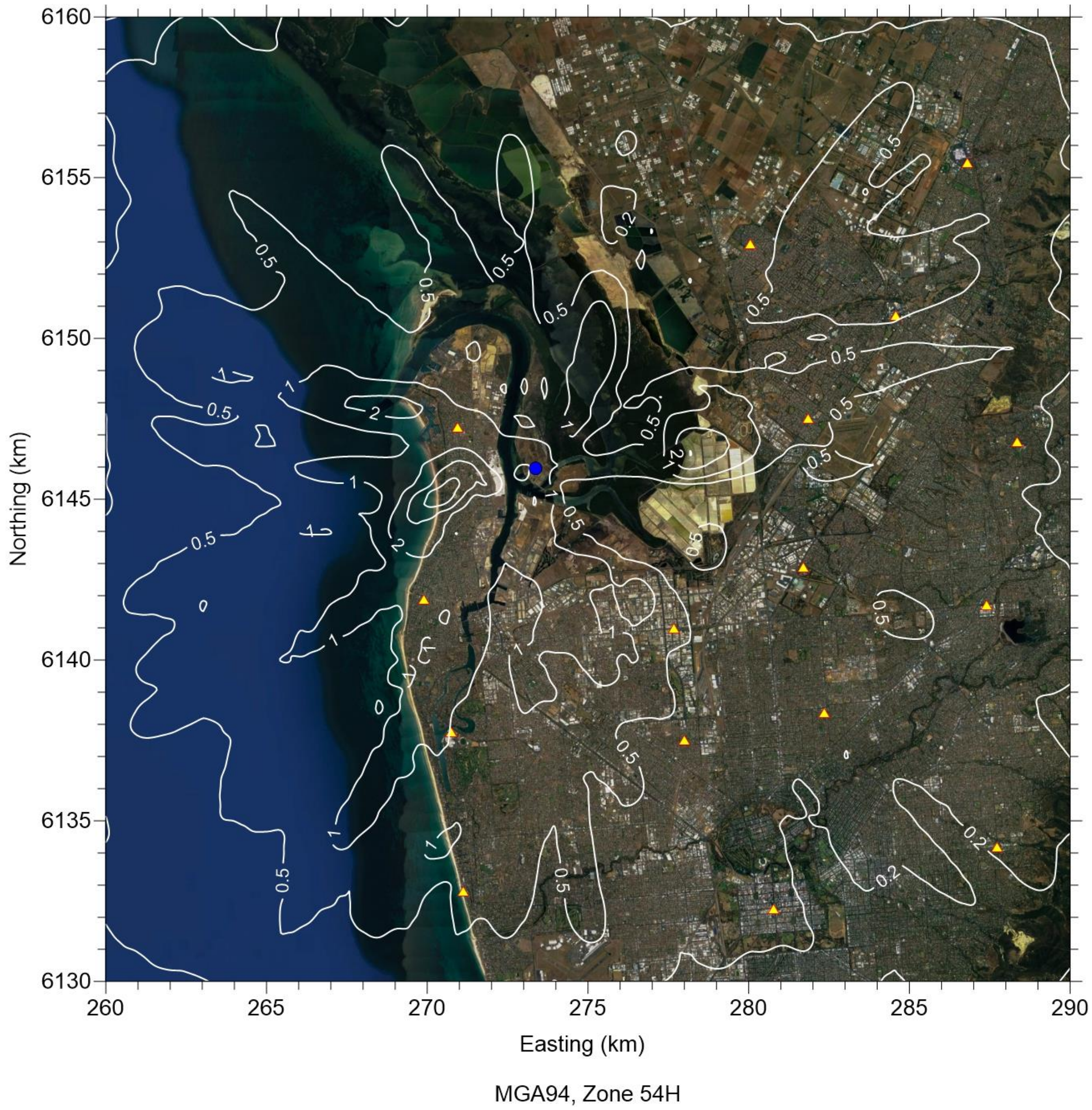


Figure 6-31: Stage 1 + Stage 2 Project – Natural Gas Operation with TIPS B (maximum load), incremental maximum 3 minute average benzene (µg/m³)

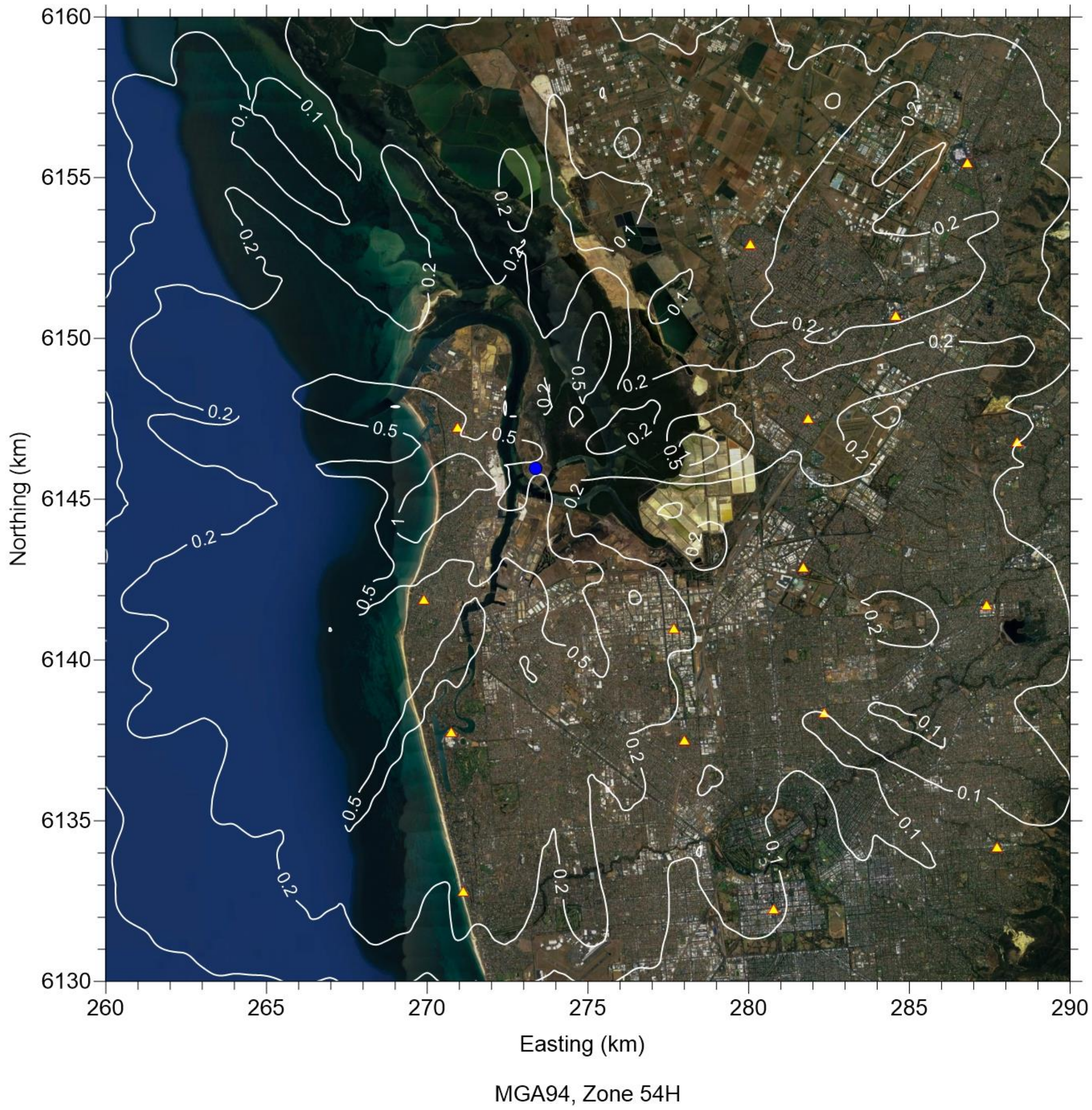


Figure 6-32: Stage 1 + Stage 2 Project – Diesel Operation with TIPS B (maximum load), incremental maximum 3 minute average benzene (µg/m³)

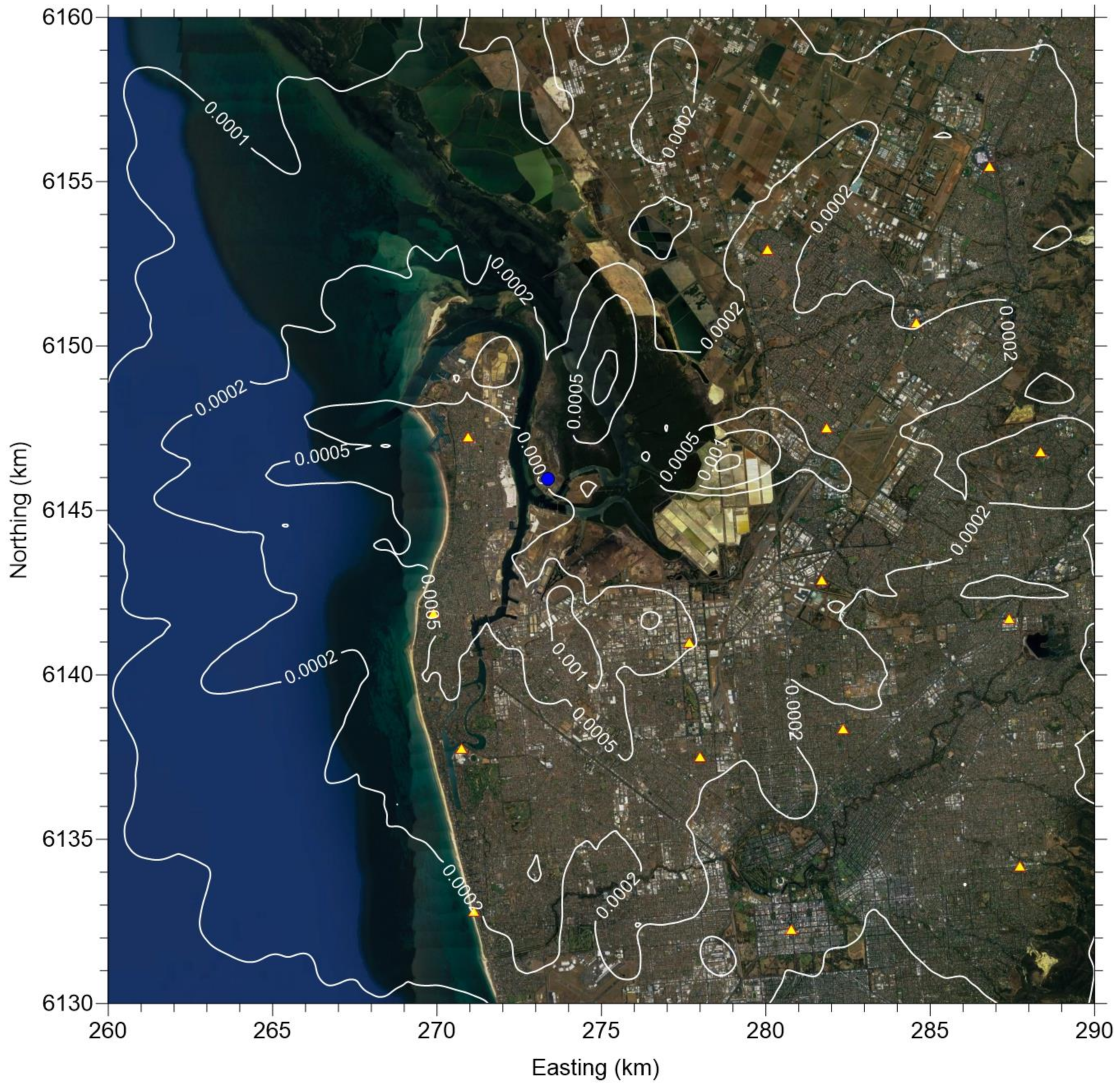


Figure 6-33: Stage 1 + Stage 2 Project – Natural Gas Operation with TIPS B (maximum load), incremental maximum 3 minute average PAHs as benzo(a)pyrene (µg/m³)

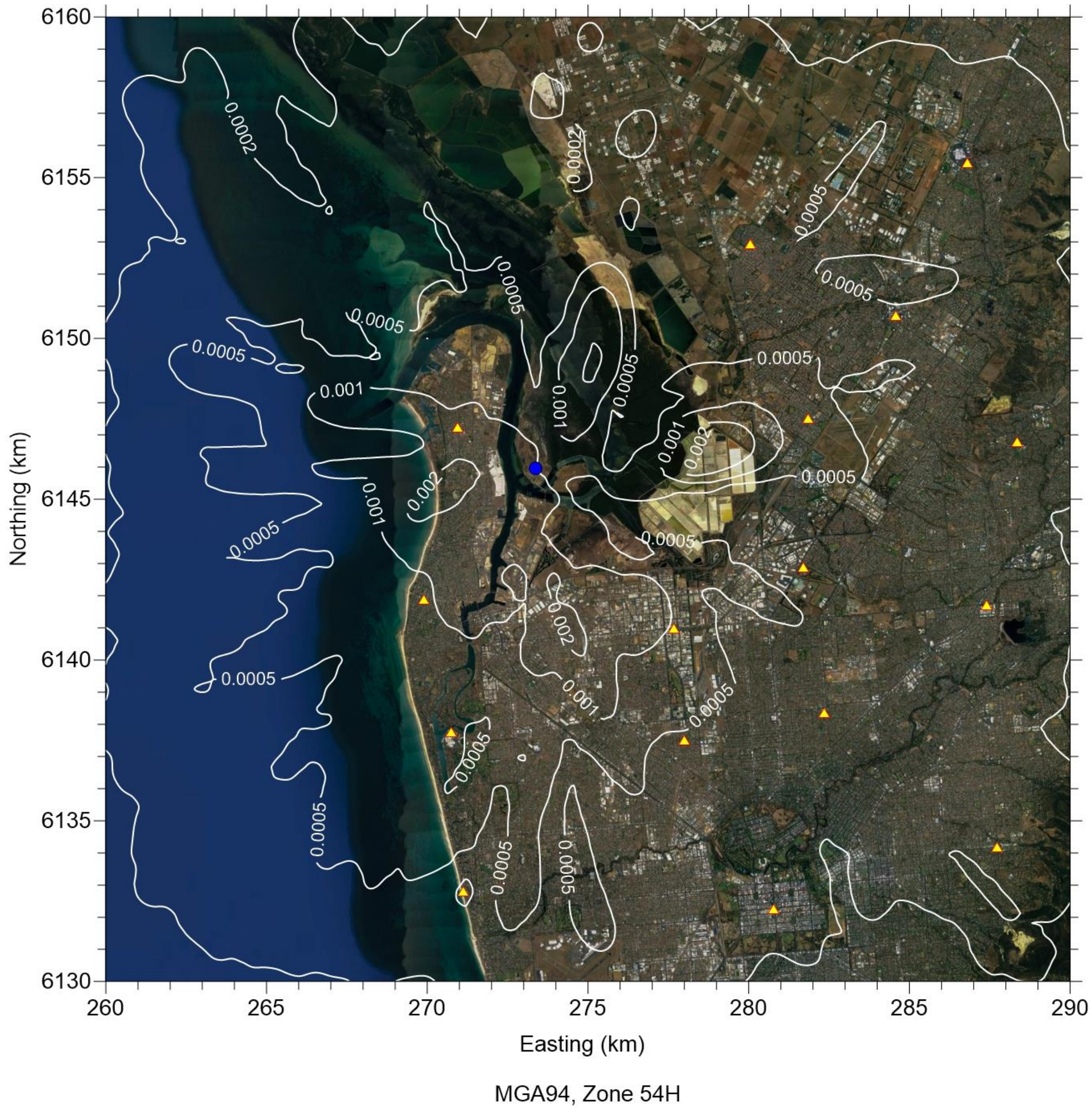


Figure 6-34: Stage 1 + Stage 2 Project – Diesel Operation with TIPS B (maximum load), incremental maximum 3 minute average PAHs as benzo(a)pyrene (µg/m³)

7 Conclusions

The operation of the proposed Barker Inlet Power Station has been assessed for potential impacts on ambient air quality in the region. The assessment has been undertaken using atmospheric dispersion modelling in accordance with regulatory methodologies, and a range of Project and geography specific inputs.

A review of proposed generation technology identified key pollutants, as well as relevant emission controls, which as proposed, include Selective Catalytic Reduction (SCR) of NO_x emissions, use of low sulphur fuels (as relevant to sulphur dioxide and sulphate particulate), as well as combustion controls for the minimisation of primary NO_x and CO emissions.

Emissions from the Project have been quantified based on a combination of manufacturer data, fuel specifications, and industry references, including the US EPA AP-42 emission factor database. These emission estimates have been applied in dispersion modelling, which has been undertaken using the CALPUFF dispersion modelling package with a site specific CALMET meteorological dataset. CALMET was run in a nested configuration for the year 2009, based on surface observations from a total of 21 Bureau of Meteorology automatic weather stations, in conjunction with upper air meteorological data, sourced from Adelaide airport.

Dispersion modelling has been conducted for key pollutants, and for a range of operational and cumulative scenarios. Results have then been assessed against regulatory criteria. For NO_2, CO, PM_{10} and $PM_{2.5}$, cumulative impacts have been assessed as the sum of:

- Existing ambient background levels as measured by SA EPA ambient air quality modelling sources.
- Dispersion modelling of emissions the existing TIPS B power station.
- Dispersion modelling of emissions from the Project.

Nitrogen dioxide concentrations have been based on the Ozone Limiting Method, in conjunction with hourly-varying ozone and NO_2 data sourced from the SA EPA Netley monitoring station. CO, SO_2 and PM_{10} have incorporated 70^{th} percentile background concentrations.

Hazardous air pollutants, including formaldehyde, benzene and PAHs as benzo(a)pyrene have been assessed against SA EPA impact assessment criteria on an incremental basis.

The assessment has incorporated several elements of conservatism that should be acknowledged when considering the assessment predictions:

- Power generation emissions have been assumed to occur on a continuous basis for all 8,760 hours of the annual modelling period. This provides a conservative assessment of peaking and network support operations, which are intermittent in nature. This conservatism is most pronounced in results for averaging periods beyond 1 hour in duration (e.g. $PM_{2.5}$ 24 hour and annual averages), where it is unlikely that peak operations would occur on an extended basis.
- Enhancement of plume rise via plume merging effects has been ignored. A review of stack proximity identified that in practice, plumes from neighbouring stacks will merge and experience enhanced plume rise, with an anticipated reduction in ground level concentrations.

- Netley monitoring data has been applied across the modelling domain. A review of temporal and spatial variability identified these data as being a conservative representation of air quality across the Adelaide region.

When assessed against regulatory criteria, all predictions were found to be within SA EPA impact assessment criteria with the exception of annual average $PM_{2.5}$, for which the background was estimated to be exceeding the annual criterion. Noting this, the scale of peak annual predictions (0.3 µg/m^3), when considered in conjunction with conservative assumption around operating frequency, implies that the likelihood of the Project resulting in a measurable contribution to cumulative $PM_{2.5}$ concentrations is minor.

Accordingly, based on the analysis documented within this assessment, the potential for the Project to result in adverse air quality impacts is considered minor.

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Appendix A

Summary of CALPUFF Model Parameters

Table A-1: Meteorological Parameters used for TAPM and CALMET

CALMET Outer Grid	Setting
Meteorological grid domain	300 km x 210 km
Meteorological grid resolution	2.0 km
Surface meteorological parameters	- Wind speed - Wind direction - Temperature - Relative humidity -Cloud amount
Upper air	Adelaide Airport
CALMET Inner Grid	
Meteorological grid domain	30 km x 30 km
Meteorological grid resolution	0.5 km
Surface meteorological stations	- Wind speed - Wind direction - Temperature - Relative humidity -Cloud amount
Upper air	CALMET Outer Domain

Table A-2: CALPUFF Model Options used

Flag	Flag Descriptor	Value Used	Value Description
MCHEM	Chemical transformation	0	Not modelled
MDRY	Dry deposition	1	Yes
MTRANS	Transitional plume rise allowed?	1	Yes
MTIP	Stack tip downwash?	1	Yes
MRISE	Method to compute plume rise	1	Numerical plume rise
MSHEAR	Vertical wind shear	0	Vertical wind shear not modelled
MPARTL	Partial plume penetration of elevated inversion?	1	Yes
MSPLIT	Puff splitting	0	No puff splitting
MSLUG	Near field modelled as slugs	0	Not used
MDISP	Dispersion coefficients	3	PG Dispersion Curves
MPDF	Probability density function used for dispersion under convective conditions	0	No
MROUGH	PG sigma y,z adjusted for z	0	No
MCTADJ	Terrain adjustment method	3	Partial Plume Adjustment
MBDW	Method for building downwash	1	Prime

Appendix B

Cumulative 1 hour NO_2 contour isopleths

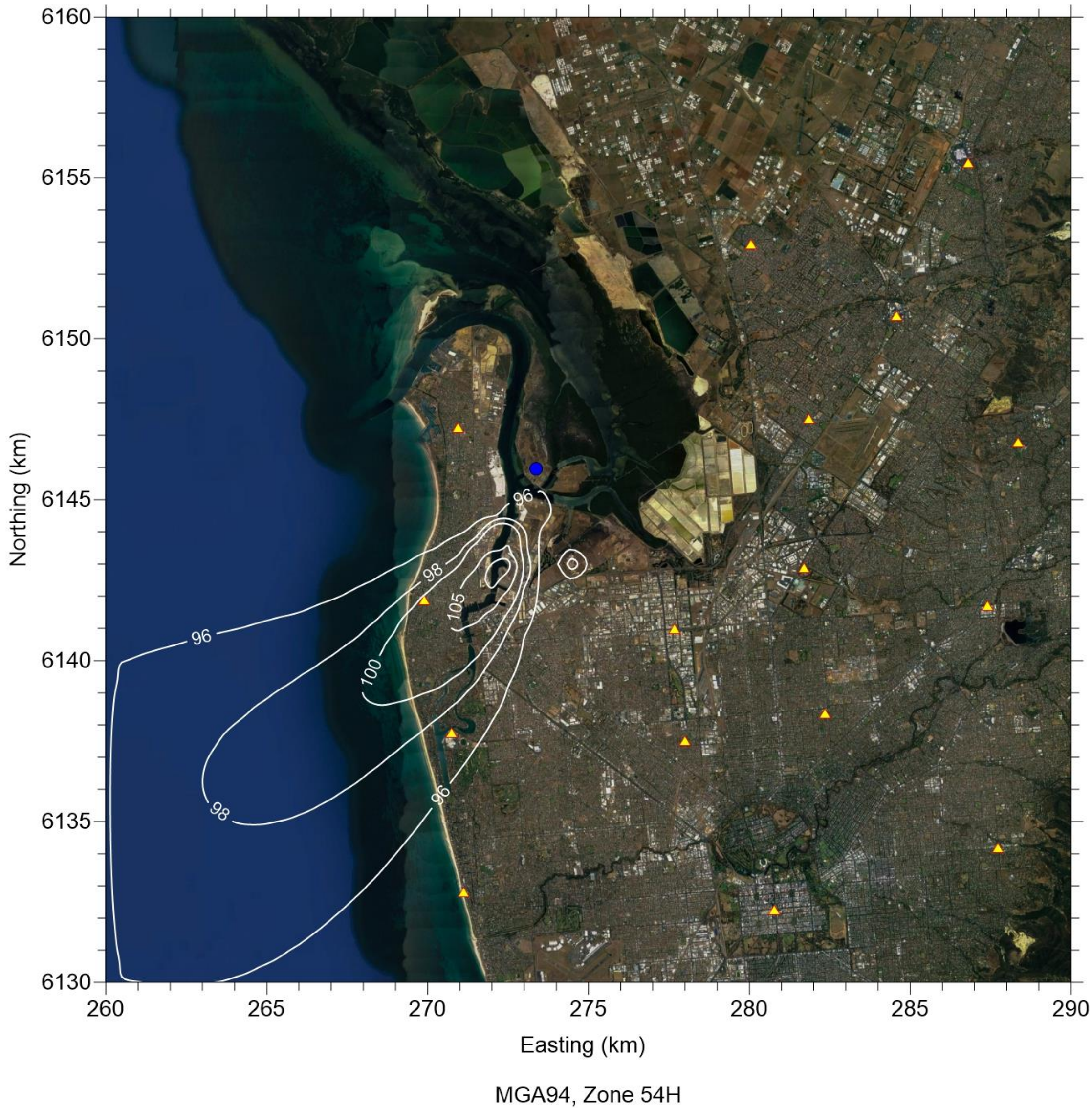


Figure B-1: Stage 1, Project Only – Natural Gas Operation, cumulative (i.e. including background) maximum 1 hour NO_2 (µg/m³)

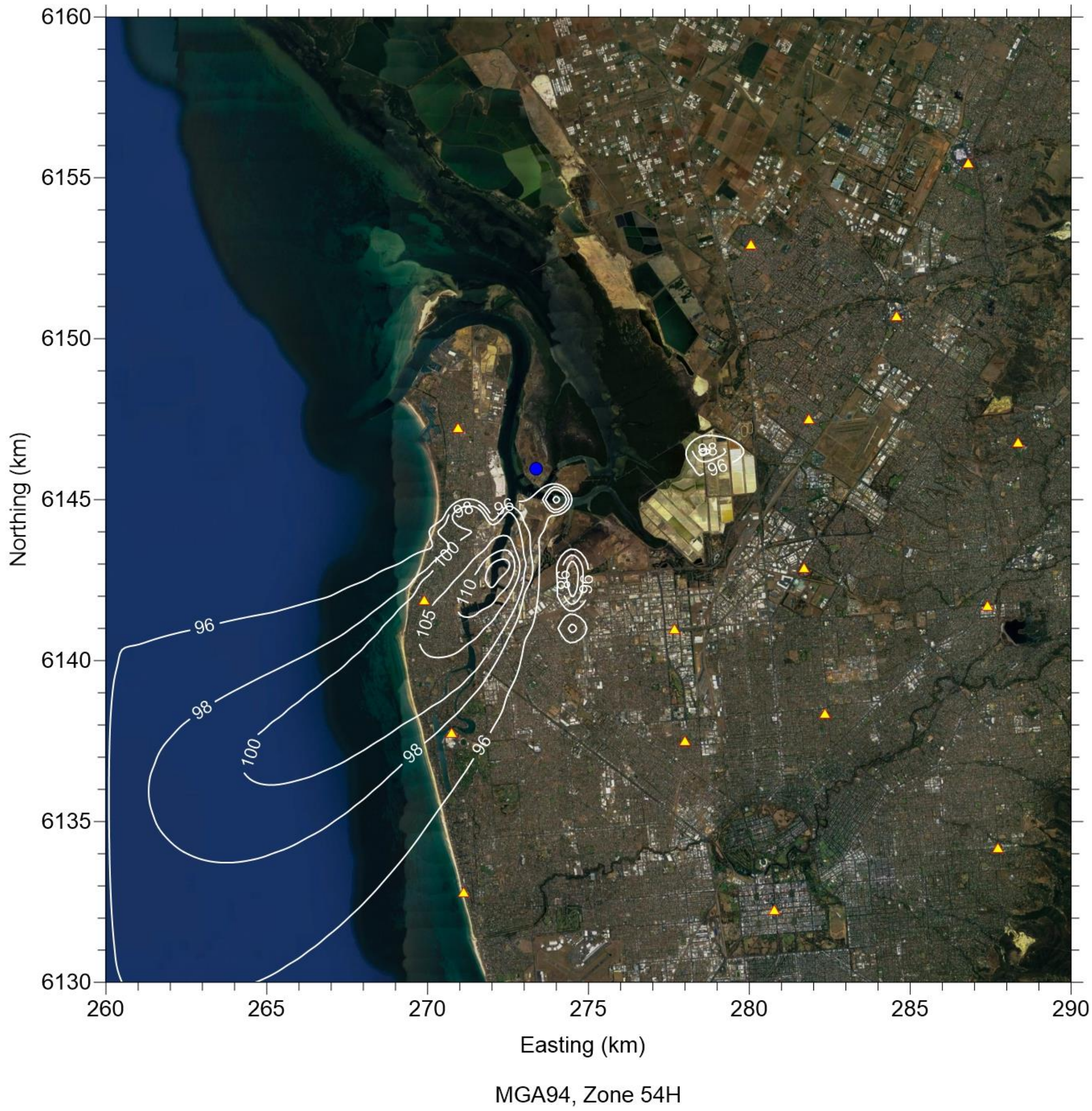
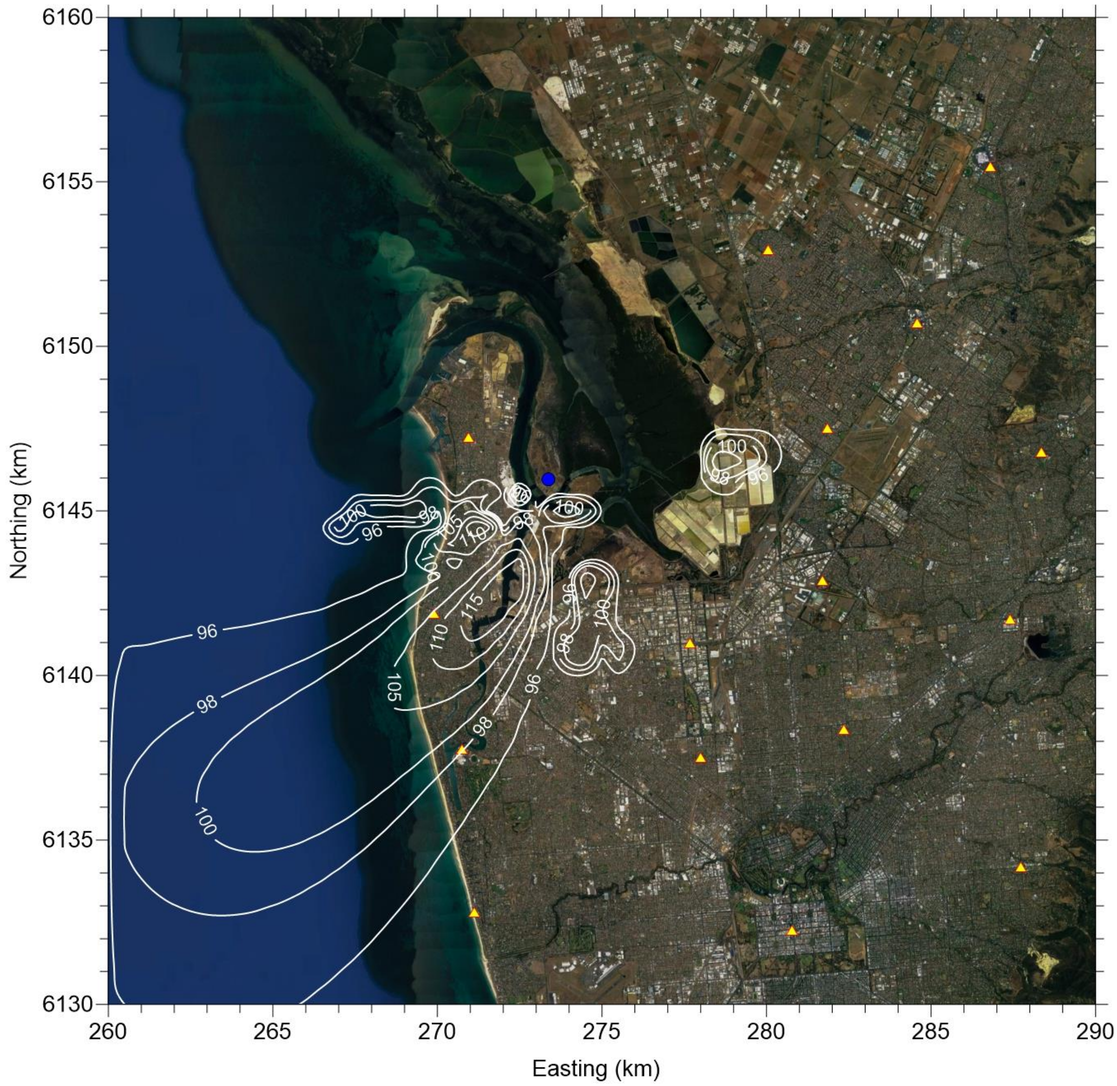


Figure B-2: Stage 1, Project Only – Diesel Operation, cumulative (i.e. including background) maximum 1 hour NO_2 (µg/m³)



MGA94, Zone 54H

Figure B-3: Stage 1 + Stage 2, Project Only – Natural Gas Operation, cumulative (i.e. including background) maximum 1 hour NO_2 (µg/m³)

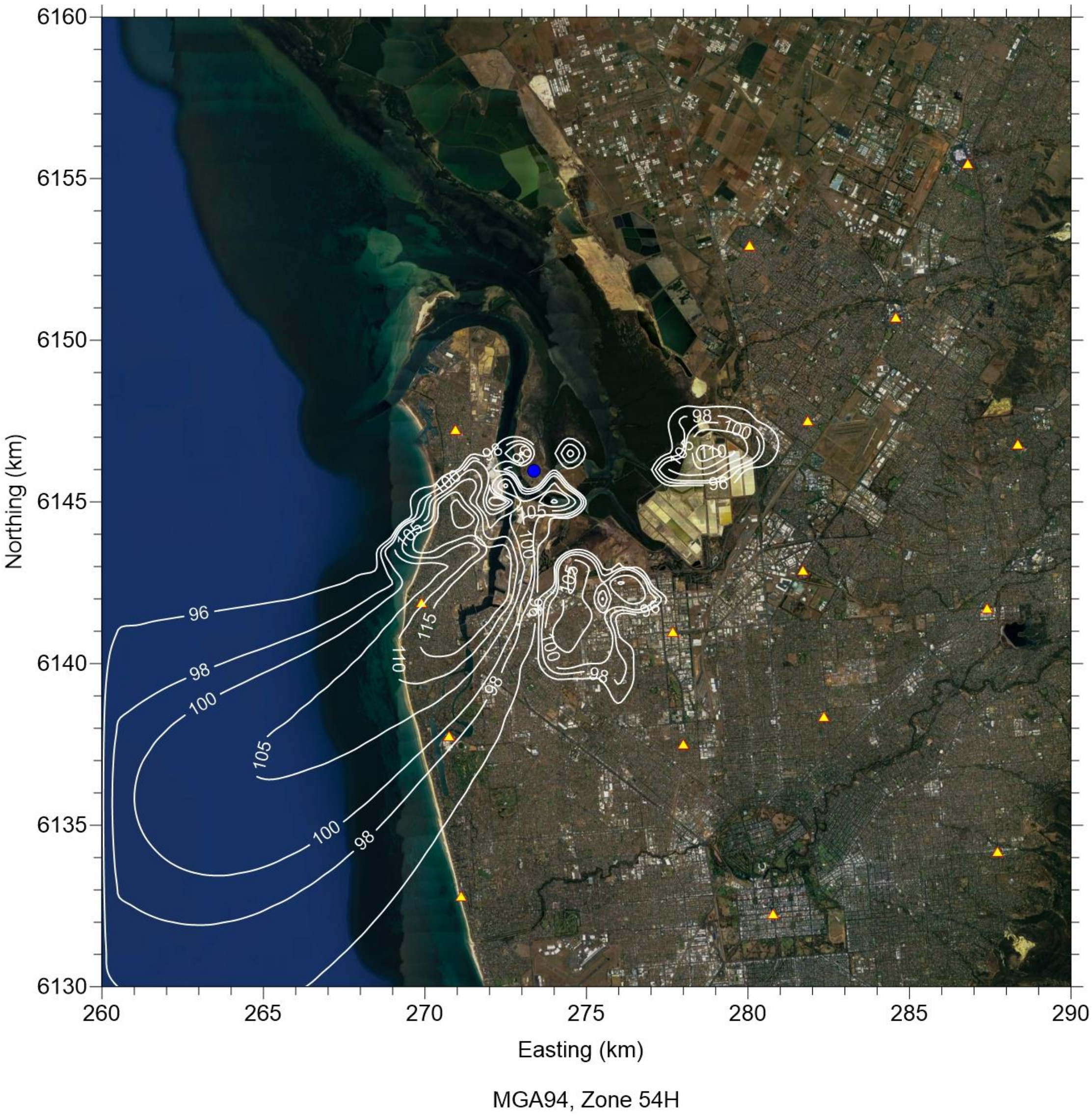


Figure B-4: Stage 1 + Stage 2, Project Only – Diesel Operation, cumulative (i.e. including background) maximum 1 hour NO_2 (µg/m³)

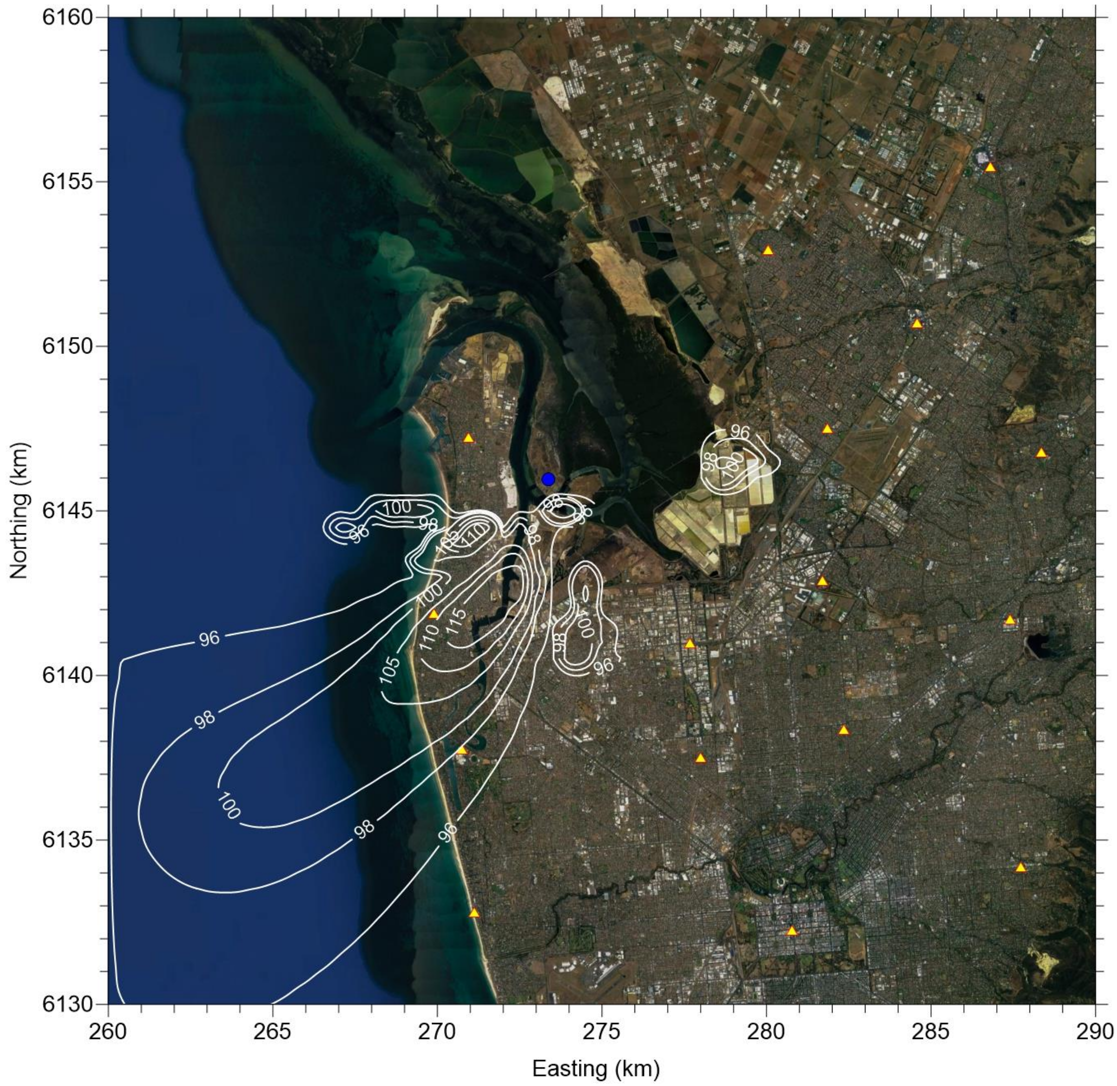
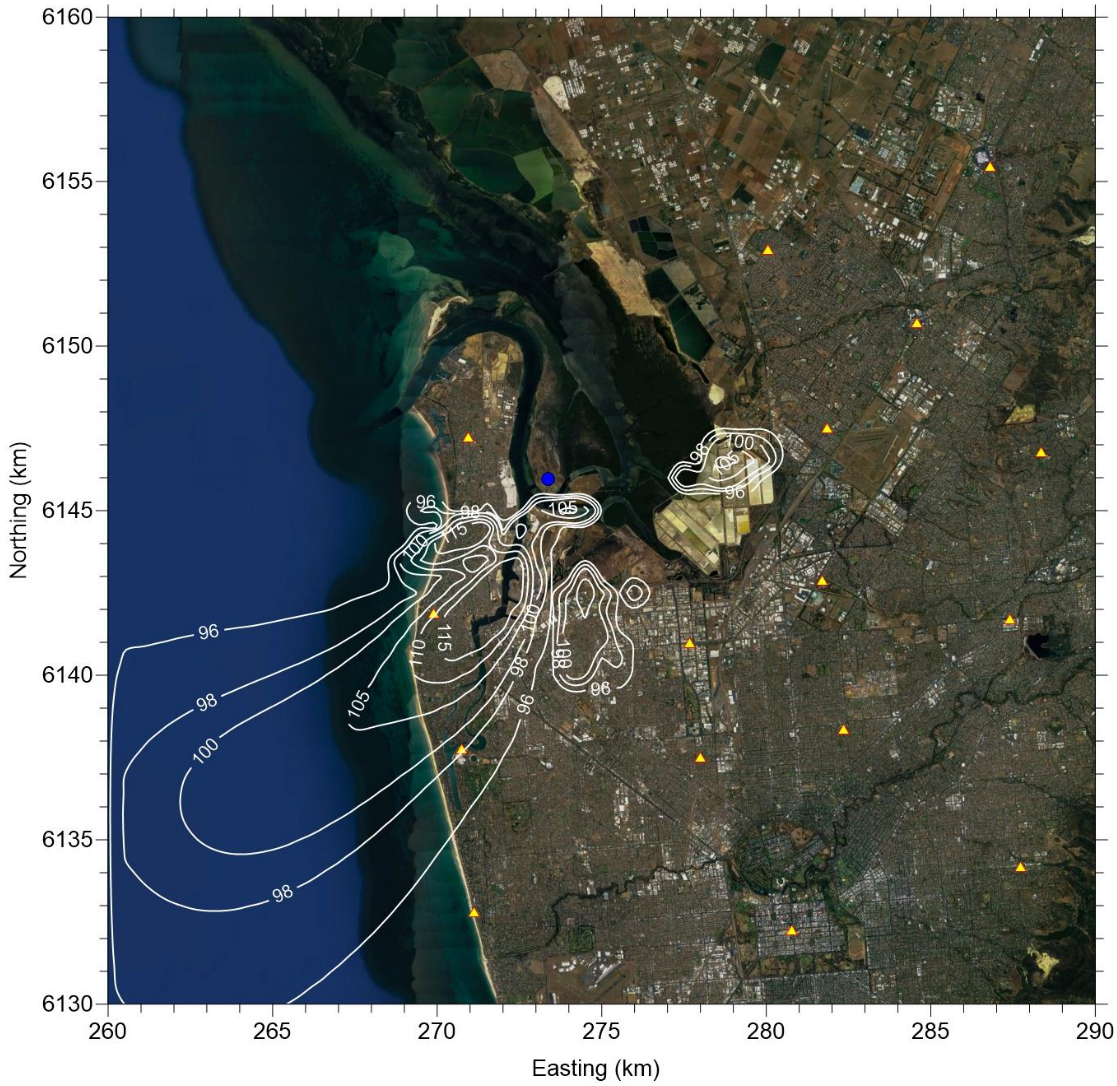
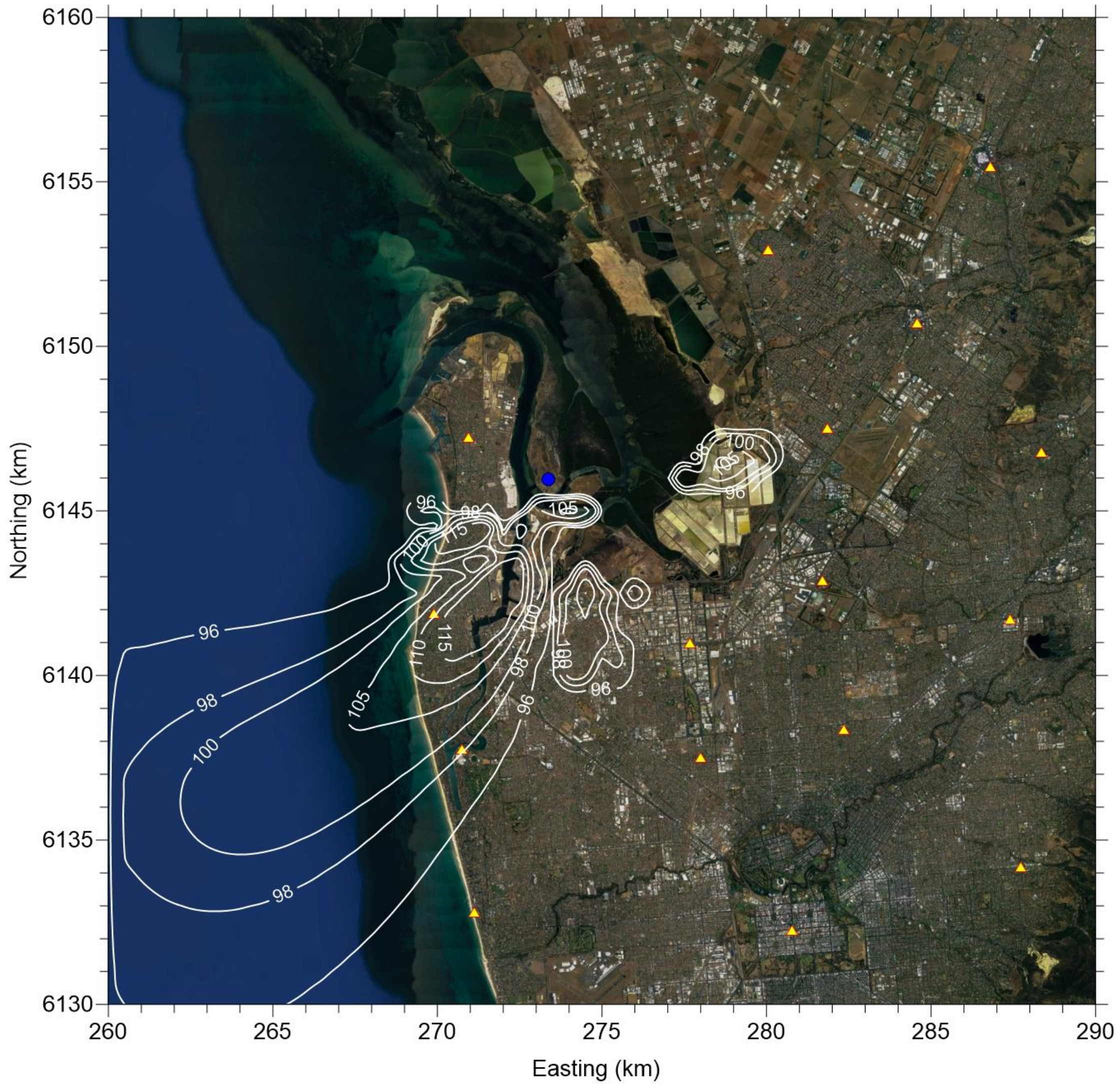


Figure B-5: Stage 1, Project – Natural Gas Operation, TIPS B (typical load), cumulative (i.e. including background) maximum 1 hour NO_2 ($\mu g/m^3$)



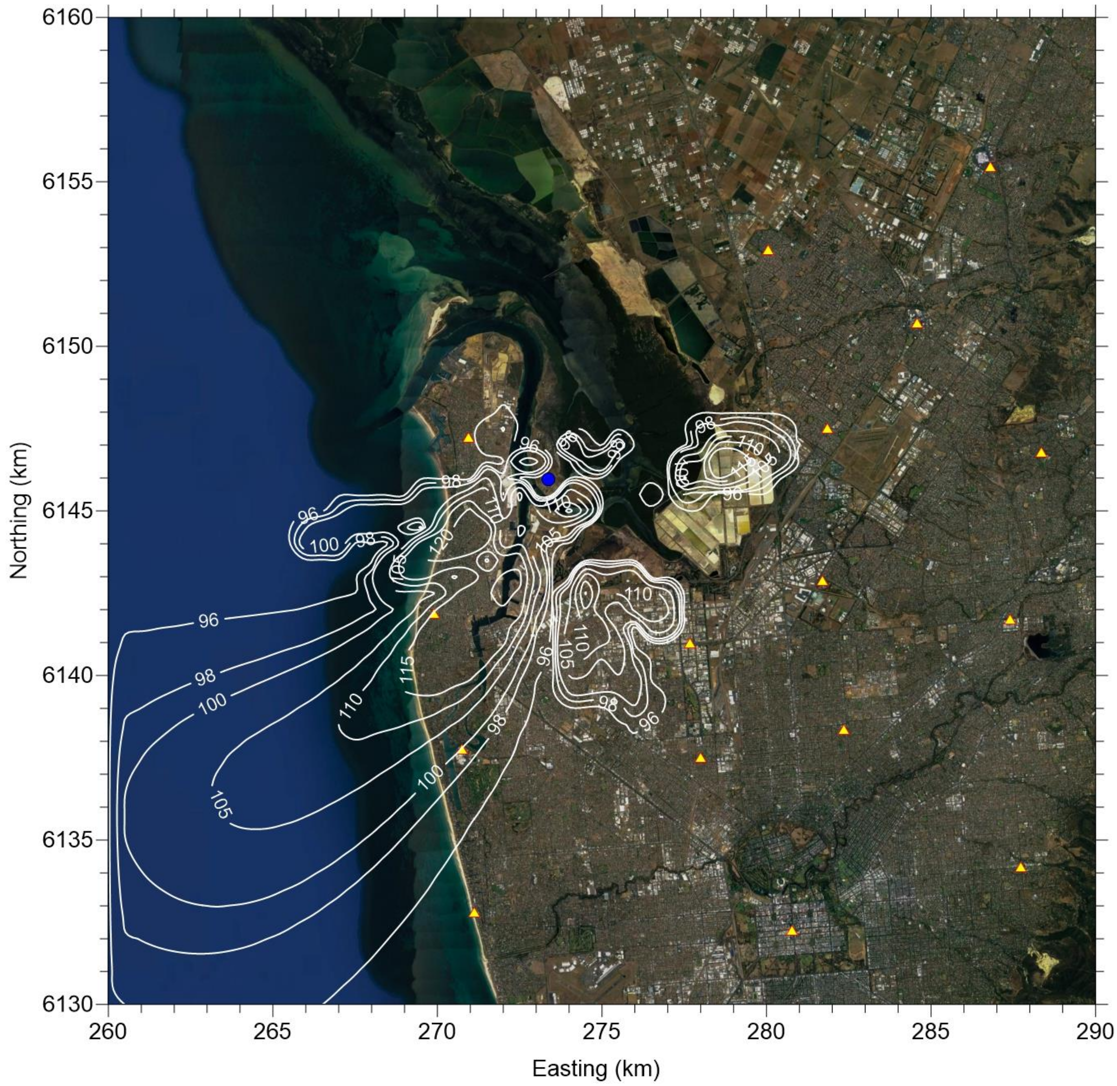
MGA94, Zone 54H

Figure B-6: Stage 1, Project – Diesel Operation with TIPS B (typical load), cumulative (i.e. including background) maximum 1 hour NO_2 (µg/m³)



MGA94, Zone 54H

Figure B-7: Stage 1 + Stage 2, Project – Natural Gas Operation, with TIPS B (typical load), cumulative (i.e. including background) maximum 1 hour NO_2 (µg/m³)



MGA94, Zone 54H

Figure B-8: Stage 1 + Stage 2, Project – Diesel Operation with TIPS B (typical load), cumulative (i.e. including background) maximum 1 hour NO_2 (µg/m³)

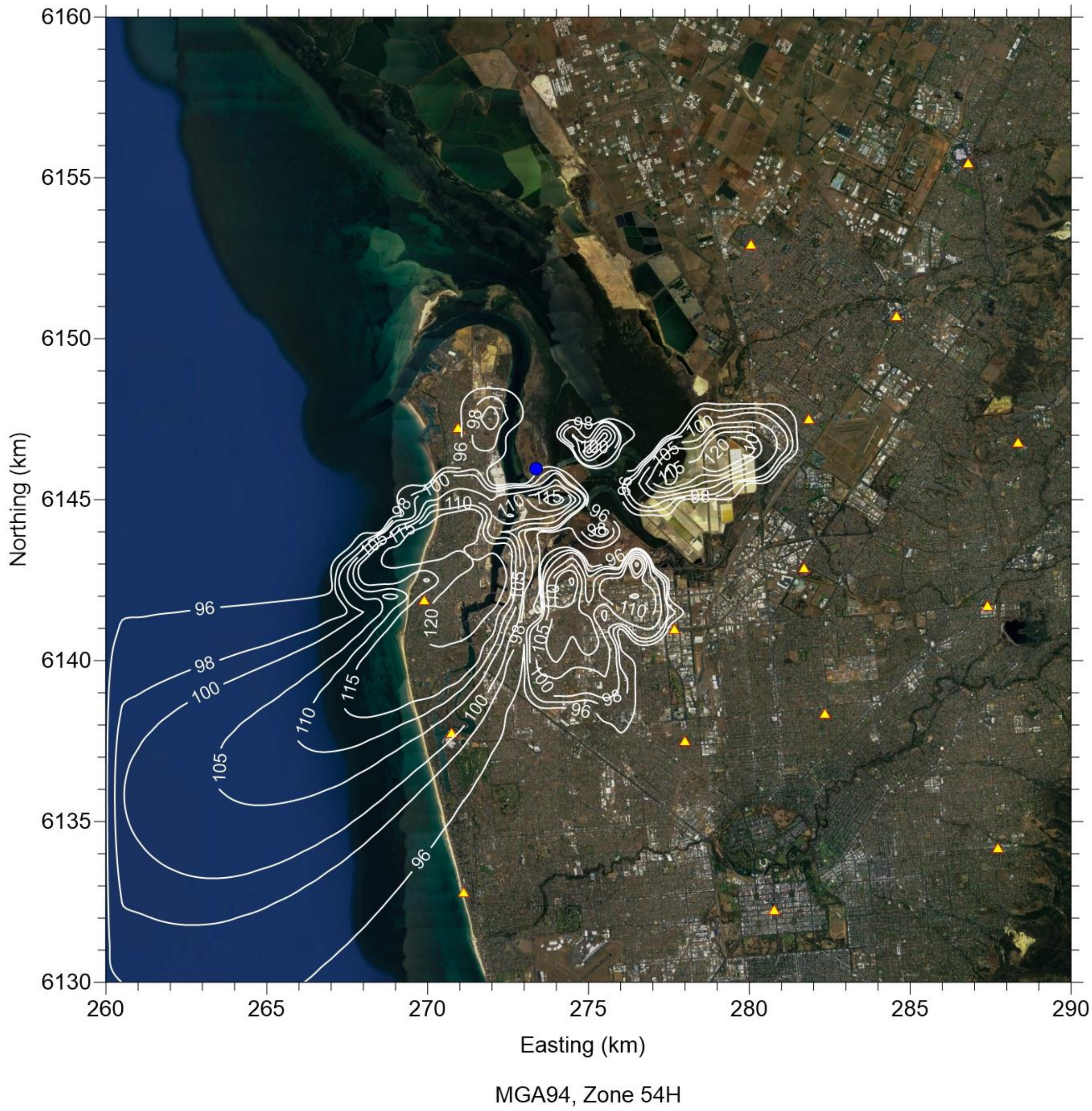
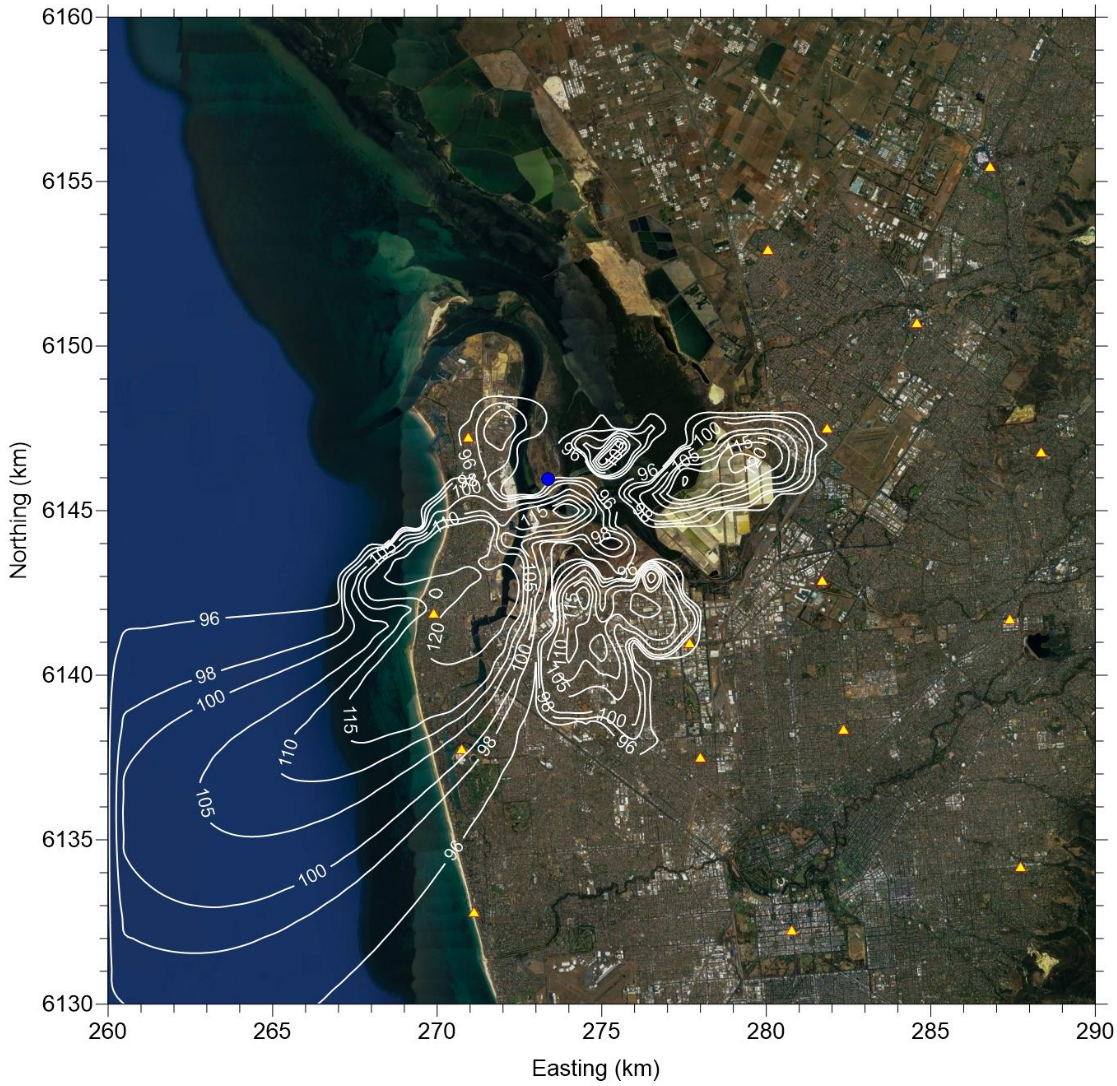


Figure B-9: Stage 1, Project – Natural Gas Operation, with TIPS B (maximum load), cumulative (i.e. including background) maximum 1 hour NO_2 (µg/m³)



MGA94, Zone 54H

Figure B-10: Stage 1, Project – Diesel Operation with TIPS B (maximum load), cumulative (i.e. including background) maximum 1 hour NO_2 (µg/m³)

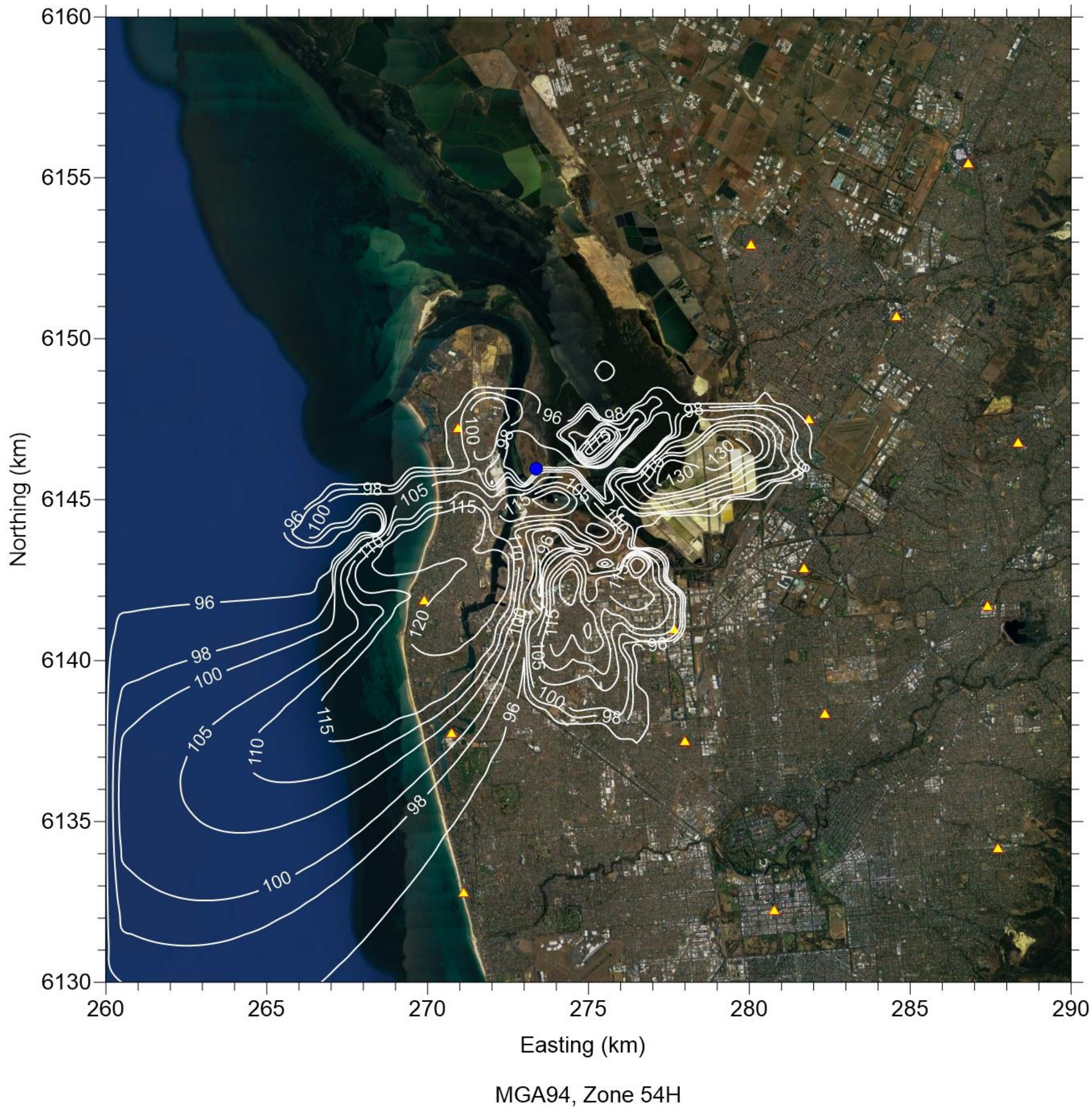
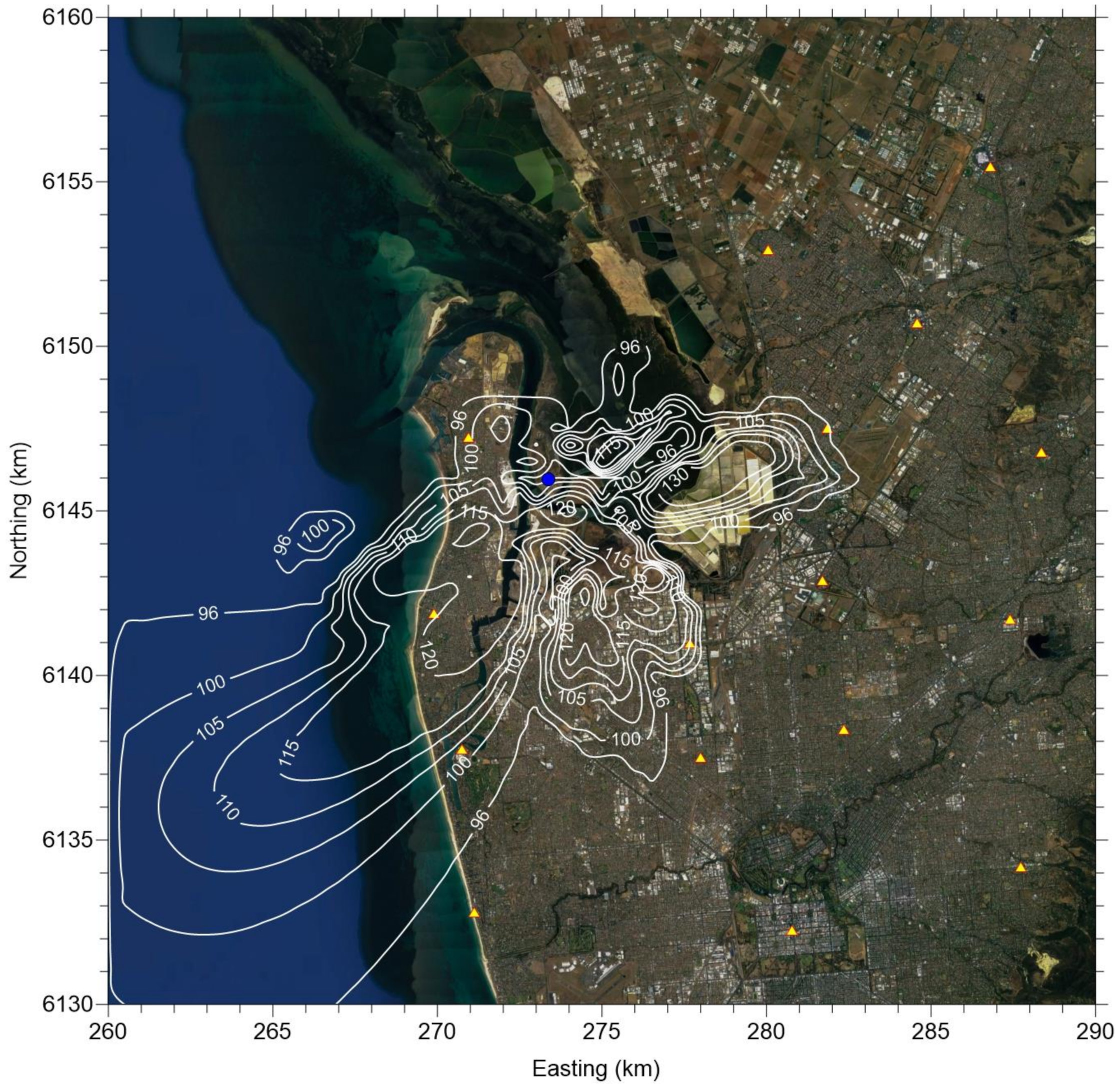


Figure B-11: Stage 1 + Stage 2, Project – Natural Gas Operation, with TIPS B (maximum load), cumulative (i.e. including background) maximum 1 hour NO_2 (µg/m³)



MGA94, Zone 54H

Figure B-12: Stage 1 + Stage 2, Project – Diesel Operation with TIPS B (maximum load), cumulative (i.e. including background) maximum 1 hour NO_2 (µg/m³)

Appendix H

CASA plume assessment

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The OAR has conducted a Screening Tool assessment of the proposed facility at Torrens Island based on the parameters supplied. We note that the parameters supplied for the existing Torrens Island Power Station differ slightly from those recently supplied to CASA in a review conducted in 2016 which resulted in a 10.6m/s plume of 639FT AGL (or 111FT above the stack top). The parameters you supplied result in a lower result of 592FT AGL. The result from the existing facility is needed in order to consider any merging of the plumes from the two sites. Images are attached showing the existing site and the symbol indicated on the visual terminal chart.

The OAR Screening Tool was used to determine the height of the 10.6m/s plume from the proposed facility as there are no instrument approach considerations at the site. The result was 148 FT AGL (49FT above the stack top) as attached. This result is lower than the existing facility which is already represented by a plume symbol on aviation charts.

Table 1: BIPS Results

Project:	Barker Inlet Power Station - 10.6 result
Date created:	30/08/2017 15:26:00
Number of Stacks:	4
Stack Separation:	65.00 m
Stack Diameter:	3.92 m
Temperature:	377.85 Deg.C
Exit Velocity:	28.90 m/s
Stack height:	30.00 m
Critical velocity:	10.6
Critical height:	45 m (148 ft) AGL
	15 m (49 ft) Above stack top

The OAR Screener Tool can only be used to assess merging where the plume parameters are the same. Therefore it would not be accurate to use the tool to estimate the result. However, guidance from the plume consultants who produced the tool is that plumes are only likely to merge if the critical plume heights would reach each other if laid horizontally. I note that the distance between the facilities is approximately 214m (740FT) at the closest point and the other stack groupings are a further 65m (213FT) from that stack group. Therefore any merging is likely to be limited to the closest stack grouping, which on its own cannot achieve the full plume height of 148FT which is represented by the merging of the 4 stack groupings. Therefore, any merging that results from the two facilities can be considered negligible.

The OAR assessment of the proposal is that no further mitigation is required for the plume rise exhaust from the proposed facility.

Thank you for referring this proposal. Kind Regards,
Anna

Anna Scott
Airspace Regulation Specialist
Office of Airspace Regulation
Air Navigation, Airspace and Aerodromes Branch

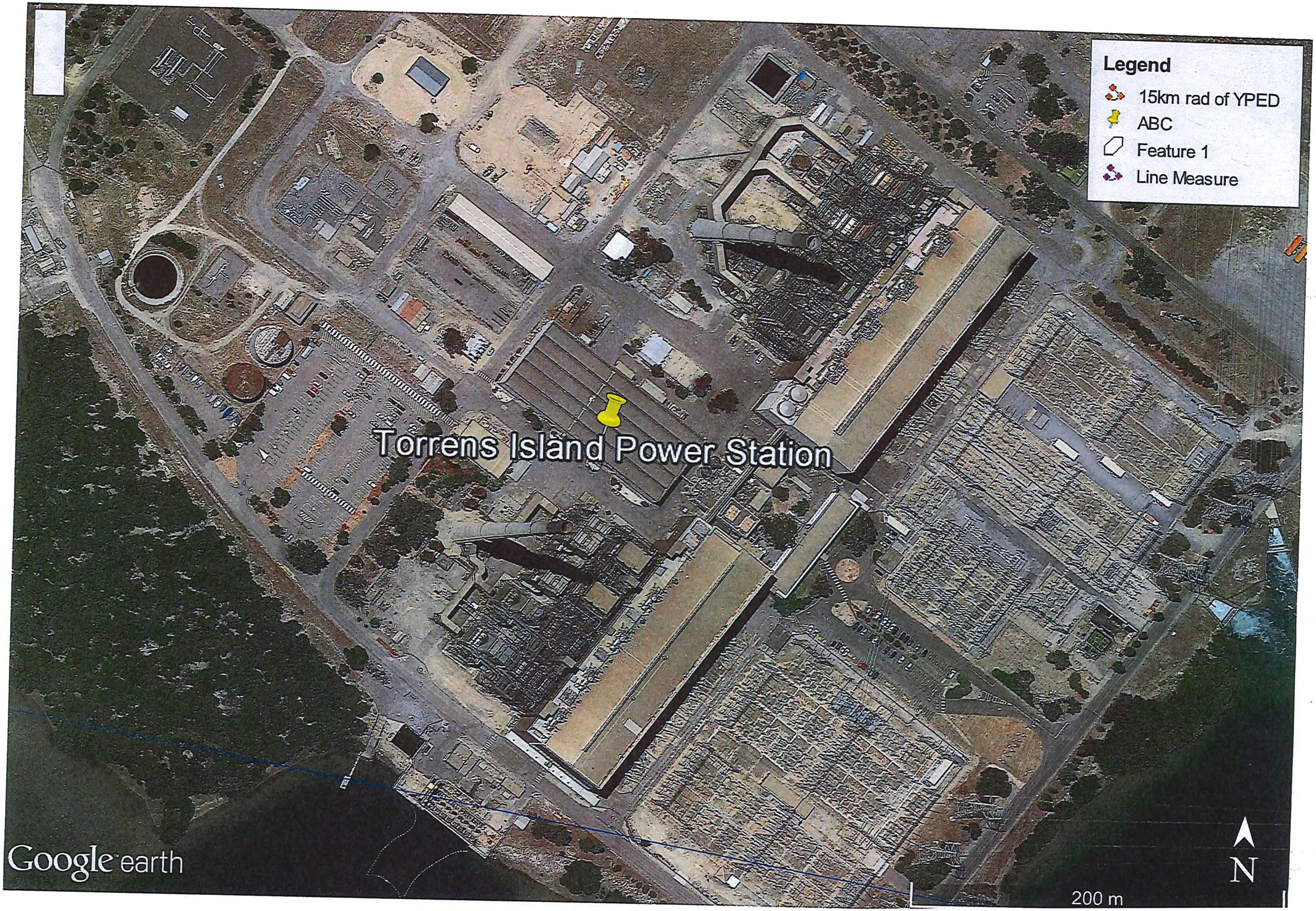
CASA\Aviation Group
p: 02 6217 1419 **m:** 0423 829 737
GPO Box 2005, Canberra ACT 2601

www.casa.gov.au

Attachments: Images

FOR USE UP TO A

Highest point on chart 2732 at 34°59' 138°42'


Legend
15km rad of YPED
ABC
Feature 1
Line Measure
Torrens Island Power Station
Google earth
N
200 m

Appendix I

Greenhouse gas assessment

Report

AGL Barker Inlet Power Station Greenhouse Gas Assessment

Document control number: AQU-NW-003-21872B

Date: 19 September 2017

Pacific Environment

Project name: AGL Barker Inlet Power Station Greenhouse Gas Assessment

Document control number: AQU-NW-003-21872B

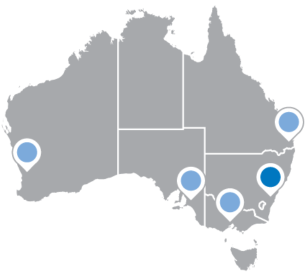
Prepared for: Coffey Services Australia P/L

Approved for release by: D. Roddis

Disclaimer & copyright:

Table 1-1. *Document Control*

Version	Date	Comment	Prepared by	Reviewed by
01	08.08.2017	Draft	J. Firth	K. Kulkarni
02	14.09.2017	Revised draft	J. Grieve	D. Roddis
03	19.09.2017	Final	J.Grieve	J. Firth



Adelaide

5 Peel Street,
Adelaide SA 5000
Ph: +61 8 8332 0960
Fax: +61 7 3844 5858

Brisbane

Level 19, 240 Queen Street
Brisbane Qld 4000
Ph: +61 7 3004 6400
Fax: +61 7 3844 5858

Melbourne

Level 6, 99 King Street
Melbourne Vic 3000
Ph: +61 3 9111 0021
Fax: +61 2 9870 0999

Perth

Level 1, Suite 3
34 Queen Street, Perth WA 6000
Ph: +61 8 9481 4961
Fax: +61 2 9870 0999

Sydney Head Office

Suite 1, Level 1, 146 Arthur Street
North Sydney, NSW 2060
Ph: +61 2 9870 0900
Fax: +61 2 9870 0999

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1 Executive summary

Pacific Environment was commissioned by Coffey Services Australia P/L (Coffey) to undertake a Greenhouse Gas Assessment (GHGA) for a proposed power station development (the Project) adjacent to AGL's Torrens Island facility in South Australia.

AGL propose to expand the existing power station on Torrens Island, located in the southwestern portion of the island and about 15 km northwest of the central business district of metropolitan Adelaide. The development will comprise a new power station, referred to as the Barker Inlet Power Station (BIPS) and it will be located adjacent to AGL's existing Torrens Island Power Station (TIPS).

The new power station will replace 50 year old generating capacity at the TIPS A Station that has reached the end of its life. The first two A Station units will be mothballed in September 2019 following BIPS entering commercial operation. The remaining two units will be mothballed progressively in 2020 and 2021.

The proposed BIPS will be built in two stages of 210 MW each with a total generation capacity of approximately 420 MW. Each stage will comprise 12 dual fuel reciprocating engines each rated at 18MW. The timing of the second stage of the Project will be dependent energy market conditions and so has not been finalised at this time.

While the new plant will operate predominately on natural gas the new configuration will also allow the option of diesel firing. The existing fuel oil firing capacity at TIPS B Station will be taken out of service and liquid fuel generating capability will be transferred from TIPS B to BIPS.

The existing A and B Stations at TIPS have very long start times requiring some units to operate at low load during low demand periods in order to be ready to dispatch during peak demand periods. The new BIPS station, which is capable of achieving full load five minutes after starting, will avoid considerable quantities of gas currently consumed during low demand periods by operating only when required by the market.

Scope 1 and Scope 3 greenhouse gas emissions for the Project were estimated for two operational scenarios, using national greenhouse gas emission estimation methodologies. AGL provided estimates of fuel consumption that recognise the interaction between the TIPS and BIPS.

The Scope 1 emissions of 830 kt CO_2-e and 1,045 kt CO_2-e have been estimated for Scenario 1 and Scenario 2 respectively. The overall contribution (Scope 1 and Scope 3) of the Stage 1 BIPS and TIPS operation would be 0.19% and 0.23% of national emissions for Scenarios 1 and 2 (respectively). It is noted that a large proportion of these emissions would not be additional given that TIPS emissions have been included within accounting totals.

AGL propose to employ a number of mitigation measures at the Project site to minimise the generation of GHG emissions. Such measures will include engineering and operational considerations.

Table of contents

List of Figures

List of Tables

1 Introduction

Pacific Environment has been commissioned by Coffey Services Australia P/L (Coffey) to undertake a Greenhouse Gas Assessment (GHGA) for a proposed power station development (the Project) at Torrens Island in South Australia.

AGL propose to expand the existing power station operations on Torrens Island, located in the southwestern portion of the island and about 15 km northwest of the central business district of metropolitan Adelaide. The new power station is referred to as the Barker Inlet Power Station (BIPS) and it will be located adjacent to AGL's existing Torrens Island Power Station (TIPS).

In 2009, AGL received approval for an expansion of power generation on Torrens Island, which has not been progressed to date. A new development application for the BIPS will be submitted by AGL.

1.1 Objectives of the Study

The primary objectives of the study are to estimate the greenhouse gas emissions (GHG) resulting from the operation of the Project, in addition to the existing power station (TIPS). Also included is a review of the emissions intensity of the proposed dual fuel gas engine generator technology.

The assessment considers the operational phase (fuel combustion) of the Project. GHG emissions from the construction stages for BIPS are anticipated to be minor when compared to operational GHG emissions.

1.2 Project Overview

The Project involves the expansion of existing operations to support growth in peak electricity demand, whilst also providing a more reliable supply of energy to SA customers in light of the proposed mothballing plans for TIPS A. To do this, AGL proposes to develop up to 420 MW of peaking generation capacity over a two stage development process (hereafter referred to as 'Stage 1' and 'Stage 2').

As part of Stage 1, the revised configuration will initially have 12 reciprocating engines capable of producing 210 MW of electricity, with a Stage 2 expansion of an additional 12 engines producing a further 210 MW of electricity.

The new configuration would operate on gas and would also have the option of diesel fuel firing, which would be implemented if the market conditions are more suitable, or if emergency conditions arise during a time at which the natural gas supply is interrupted.

1.2.1 Reciprocating engines

The proposed reciprocating engines were originally developed for marine applications, primarily LNG ships engines using readily available natural gas as fuel. These engines are currently used for power generation projects across the world. Their typical power generation application is in relatively weak electricity grids, including large mines, and in support of variable generation sources such as wind farms.

The engine type is fuel versatile, and can be run on low pressure natural gas or liquid fuel. In the gas mode, the engine is operated according to the lean-burn principle, where there is about twice as much air in the cylinder compared to the minimum needed for complete combustion of gas. This allows a controlled combustion and a high specific cylinder output without immediate risk of knocking or self-ignition when the process is well controlled. Oxides of Nitrogen (NO_x) emissions are also reduced, as the pre-dilution of the combustion air results in lower peak combustion temperatures.

In gas engines, the compression of the air/gas mixture with the piston does not heat the gas enough to start the combustion process. A liquid fuel such as diesel oil has a lower self-ignition temperature than gas and the heat in the cylinder close to the top position is enough to ignite the liquid fuel which, in turn creates enough heat to cause the air/gas mixture to burn. The amount of pilot fuel typically ranges from 1 to 5% of the total fuel consumption at full load. The engine works according to the Diesel process in liquid fuel mode and Otto principle in gas mode. The burning mixture of fuel and air expands, which pushes the piston. Finally the products of combustion are removed from the cylinder, completing the cycle. The energy released from the combustion of fuel is transferred to the engine flywheel via the moving piston. An alternator is connected to the rotating engine flywheel and produces electricity (IPPC, 2006).

Dual fuel reciprocating engines possess a range of characteristics that differ relative to gas turbine engines, which are a common peak load generation technology.

The key differences are:

- Multiple smaller units (18 MW) each operating as a single dispatchable power station.
- Smaller network capacity step changes when starting and stopping generation units thus allowing variability in plant output whilst preserving the efficiency benefits of operating plant at or near to full load.
- Faster start times (with lower associated greenhouse gas emissions); nominally 5 minutes from stopped to full load.
- Higher thermal efficiency; uses 20-30% less fuel than gas turbines and so produces less greenhouse gases per unit of electricity generated.
- Reduced waste water production.
- Diesel fuel capability to allow alternative fuel when gas prices peak beyond diesel pricing, or when the gas supply is interrupted.

The existing A and B Stations at TIPS have very long start times requiring some units to operate at low load during low demand periods in order to be ready to dispatch during peak demand periods. The new BIPS station, which is capable of achieving full load 5 minutes after starting, will avoid considerable quantities of gas currently consumed during low demand periods by operating only when required by the market.

Changes in the gas supply market across Australia have led to increased gas prices and potentially constrained physical supply. To ensure operational flexibility, particularly at time of high demand, reciprocating engines capable of firing both natural gas and distillate are proposed. Natural gas will be the predominant fuel, whilst liquid fuel will be available when gas supply is constrained or interrupted.

1.2.2 Staging of development

The Stage 1 is planned to commence construction early 2018 with commercial operation in early 2019. Mothballing of two units of the TIPS A Station will occur when Stage 1 of BIPS commences operation.

When Stage 1 is in commercial operation the fuel oil firing capacity at TIPS B will be de-commissioned. Liquid fuel operation capacity will be transferred from TIPS B to BIPS. The TIPS B heavy fuel oil firing will be replaced with those from the reciprocating engines during the rare times that liquid fuels are used.

The timing of the Stage 2 will be dependent on market conditions and as such, has not been finalised at this time.

2 Relevant legislation

2.1 International framework

2.1.1 Intergovernmental Panel on Climate Change

The Intergovernmental Panel on Climate Change (IPCC) is a panel established in 1988 by the World Meteorological Organisation (WMO) and the United Nations Environment Programme (UNEP) to provide independent scientific advice on climate change. The panel was originally asked to prepare a report, based on available scientific information, on all aspects relevant to climate change and its impacts and to formulate realistic response strategies. This first assessment report of the IPCC served as the basis for negotiating the United Nations Framework Convention on Climate Change (UNFCCC).

The IPCC also produce a variety of guidance documents and recommended methodologies for GHG emissions inventories, including (for example):

- 2006 IPCC Guidelines for National GHG Inventories; and
- Good Practice Guidance and Uncertainty Management in National GHG Inventories (2000).

Since the UNFCCC entered into force in 1994, the IPCC remains the pivotal source for scientific and technical information relevant to GHG emissions and climate change science.

The IPCC operates under the following mandate: "*to provide the decision-makers and others interested in climate change with an objective source of information about climate change*". The IPCC does not conduct any research nor does it monitor climate-related data or parameters. Its role is to assess on a comprehensive, objective, open and transparent basis the latest scientific, technical and socio-economic literature produced worldwide, relevant to the understanding of the risk of human-induced climate change, its observed and projected impacts and options for adaptation and mitigation. IPCC reports should be neutral with respect to policy, although they need to deal objectively with policy relevant scientific, technical and socio economic factors. They should be of high scientific and technical standards, and aim to reflect a range of views, expertise and wide geographical coverage" (IPCC, 2011).

The stated aims of the IPCC are to assess scientific information relevant to:

- Human-induced climate change.
- The impacts of human-induced climate change.
- Options for adaptation and mitigation.

IPCC reports are widely cited within international literature, and are generally regarded as authoritative.

2.1.2 United Nations Framework Convention on Climate Change

The UNFCCC sets an overall framework for intergovernmental efforts to tackle the challenge posed by climate change. It recognises that the climate system is a shared resource, the stability of which can be affected by industrial and other emissions of CO_2 and other GHGs.

The convention has near-universal membership, with 172 countries (parties) having ratified the treaty, the Kyoto Protocol.

Under the UNFCCC, governments:

- Gather and share information on GHG emissions, national policies and best practices.
- Launch national strategies for addressing GHG emissions and adapting to expected impacts, including the provision of financial and technological support to developing countries.
- Cooperate in preparing for adaptation to the impacts of climate change.

2.1.3 Kyoto Protocol

The Kyoto Protocol entered into force on 16 February 2005. The Kyoto Protocol built upon the UNFCCC by committing to individual, legally binding targets to limit or reduce GHG emissions. Annex I Parties (which includes Australia) are countries that were members of the Organisation for Economic Co-operation and Development (OECD) in 1992, plus countries with economies in transition such as Russia. The GHGs included in the Kyoto Protocol were:

- Carbon dioxide (CO_2)
- Methane (CH_4)
- Nitrous oxide (N_2O)
- Hydrofluorocarbons (HFCs)
- Perfluorocarbons (PFCs)
- Sulfur hexafluoride (SF_6)

Each of the above gases has a different effect on the earth's warming and this is a function of radiative efficiency and lifetime in the atmosphere for each individual gas. To account for these variables, each gas is given a 'global warming potential' (GWP) that is normalised to CO_2. For example, CH4 has a GWP of 28 over a 100 year lifetime (IPCC, 2014). This factor is multiplied by the total mass of gas to be released to provide a CO_2 equivalent mass, termed 'CO2-equivalent'.The emission reduction targets were calculated based on a party's domestic GHG emission inventories (which included land use change and forestry clearing, transportation and stationary energy sectors). Domestic inventories required approval by the Kyoto Enforcement Branch. The Kyoto Protocol required developed countries to meet national targets for GHG emissions over a five year period between 2008 and 2012.

To achieve their targets, Annex I Parties had to implement domestic policies and measures. The Kyoto Protocol provided an indicative list of policies and measures that might help mitigate climate change and promote sustainable development.

Under the Kyoto Protocol, developed countries could use a number of flexible mechanisms to assist in meeting their targets. These market-based mechanisms include:

- Joint Implementation – where developed countries invest in GHG emission reduction projects in other developed countries.
- Clean Development Mechanism – where developed countries invest in GHG emission reduction projects in developing countries.

Annex I countries that failed to meet their emissions reduction targets during the 2008-2012 period were liable for a 30 percent penalty (additional to the level of exceedance). A second commitment period was agreed in 2012 that spans from 2013 to 2020, whereby 37 countries, including Australia, were bound to emissions targets (DFAT, 2015).

2.1.4 Paris Agreement

In 2015, a historic global climate agreement was reached under the UNFCCC at the 21st Conference of the Parties (COP21) in Paris (known as the Paris Agreement). The Paris Agreement sets in place a durable and dynamic framework for all countries to take action on climate change from 2020 (that is, after the Kyoto period), building on existing efforts in the period up to 2020. Key outcomes of the Paris Agreement include:

- A global goal to hold average temperature increase to well below 2°C and pursue efforts to keep warming below 1.5°C above pre-industrial levels.
- All countries to set mitigation targets from 2020 and review targets every five years to build ambition over time, informed by a global stocktake.
- Robust transparency and accountability rules to provide confidence in countries' actions and track progress towards targets.
- Promoting action to adapt and build resilience to climate change.
- Financial, technological and capacity building support to help developing countries implement the Paris Agreement.

Australia ratified the Paris Agreement in November 2016. Australia's target under the Paris Agreement is to reduce emissions by 26-28 per cent below 2005 levels by the year 2030, progressing the levels of reduction required to meet the Kyoto Protocol targets.

2.2 Australian context

According to the Department of Environment and Energy (DoEE), Australia's GHG emissions have increased by 27.9% since 1990 reaching 534.7 Million tonnes of CO_2-equivalent ($MtCO_2$-e) in 2016 (excluding Land Use, Land Use Change and Forestry - LULUCF) (DoEE, 2016a).The electricity sector has experienced the largest growth in GHG emissions, increasing by 59.5 Mt CO_2-e between 1990 and 2016, with emissions from electricity generation increasing by 45.9% (DoEE, 2016a).

Electricity generation is still currently the largest source of emissions in the national inventory, accounting for 35% of emissions in 2016. Whilst electricity sector emissions have increased since 1990, they have declined by 22.7 Mt CO_2-e (10.7%) from peaks recorded in 2009.

2.2.1 National Greenhouse and Energy Reporting Framework

The National Greenhouse and Energy Reporting Act 2007 (Cth) (the NGER Act) establishes a mandatory obligation on corporations which exceed defined thresholds to report GHG emissions, energy consumption, energy production and other related information.

Corporate and facility reporting thresholds for GHG emissions and energy consumption or energy production are provided in Table 2-1.

Table 2-1: NGER reporting thresholds per financial year

Parameter	Reporting Threshold	
	Corporate	Facility
GHG Emissions (Scope 1&2) (kt CO_2-e)	50	25
Energy production (TJ)	200	100
Energy consumption (TJ)	200	100

Source: CER, 2017

If a corporation has operational control over facilities whose GHG emissions or energy use in a given reporting year:

- Individually exceed the relevant facilities threshold; or
- When combined with other facilities under the corporation's operational control, exceed the relevant corporate thresholds.

That corporation must report the relevant GHG emissions or energy use (as the case may be) for that year under the NGER Act. This may include construction or other contractors, for example.

It is anticipated that during construction, there will be multiple parties with operational control over different aspects of the site development. For this reason, while it is anticipated that there is likely to be some reporting requirement under the NGER scheme, this is likely to be apportioned across the NGER reporting corresponding to several corporations.

Once operational, the Project's total GHG emissions are anticipated to exceed 25,000 tonnes CO_2-e in a financial year. Because of this, the reporting of emissions is expected to be required under the NGER scheme.

The TIPS already reports under the NGER scheme.

3 Methodology

Quantification of GHG emissions has been performed in accordance with the GHG Protocol (WRI & WBCSD, 2004), IPCC and Australian Government GHG accounting/classification systems.

This GHGA is also guided by the emission estimation methodologies endorsed under the National Greenhouse and Energy Reporting Regulations 2008 (the NGER Regulations). These describe the detailed requirements for reporting under the NGER framework and also provide a basis for estimating emissions from proposed activities.

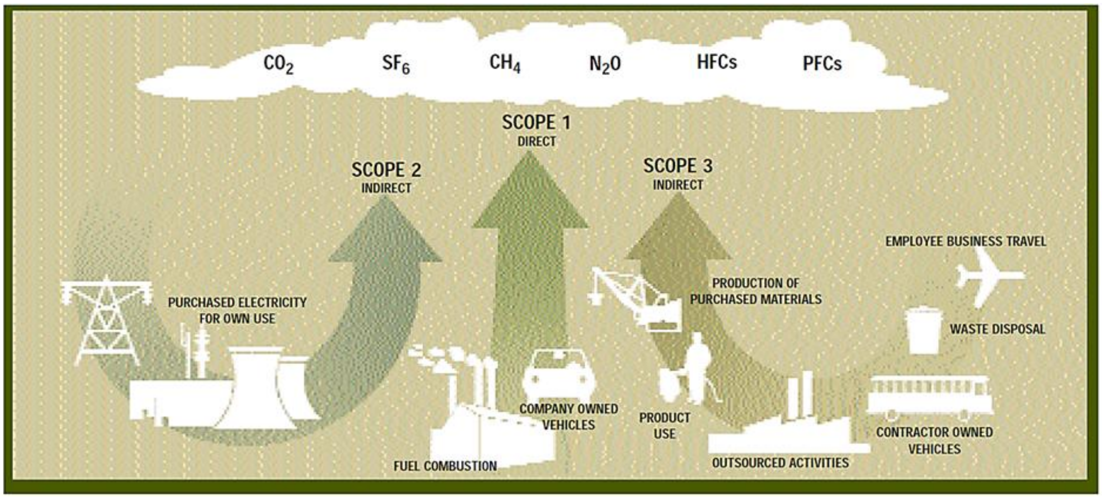
The *Technical Guidelines for the Estimation of Greenhouse Gas Emissions by Facilities in Australia* (the NGER Guidelines) (DoEE, 2016b) support reporting under the NGER Act. They have been designed to assist corporations in understanding and applying the NGER Measurement Determination.

The NGER Guidelines are reporting year specific, and outline calculation methods and criteria for determining GHG emissions, energy production, energy consumption and potential GHG emissions embodied in combusted fuels. The latest published NGER Guidelines (at the time of writing) have been referenced.

3.1 The GHG Protocol

The GHG Protocol establishes an international standard for accounting and reporting of GHG emissions. The GHG Protocol has been adopted by the International Organization for Standardisation, endorsed by GHG initiatives (such as the Carbon Disclosure Project) and is compatible with existing GHG trading schemes.

Under this protocol, three "scopes" of emissions (Scope 1, Scope 2 and Scope 3) are defined for GHG accounting and reporting purposes. This terminology has been adopted in Australian GHG reporting and measurement methods and has been employed in this assessment. The definitions for Scope 1, Scope 2 and Scope 3 emissions are provided in the following sections, with a visual representation provided in Figure 3.3.



Source: WRI & WBCSD 2004

Figure 3-1: Overview of Scopes and Emissions across a Reporting Entity

3.1.1.1 Scope 1: Direct Greenhouse Gas Emissions

Direct greenhouse gas emissions are defined as those emissions that occur from sources that are owned or controlled by the reporting entity. Direct greenhouse gas emissions are those emissions that are principally the result of the following types of activities undertaken by an entity:

- Generation of electricity, heat or steam. These emissions result from combustion of fuels in stationary sources, the principal source of greenhouse emissions associated with the operation of the TIPS power station and the proposed BIPS.
- Physical or chemical processing. Most of these emissions result from manufacture or processing of chemicals and materials, e.g., the manufacture of cement, aluminium, etc.
- Transportation of materials, products, waste and employees. These emissions result from the combustion of fuels in entity owned/controlled mobile combustion sources, e.g., trucks, trains, ships, aeroplanes, buses and cars.
- Fugitive emissions. These emissions result from intentional or unintentional releases, e.g., equipment leaks from joints, seals, packing, and gaskets; methane emissions from coal mines and venting; HFC emissions during the use of refrigeration and air conditioning equipment; and methane leakages from gas transport.

3.1.1.2 Scope 2: Energy Product Use Indirect Greenhouse Gas Emissions

Scope 2 emissions are a category of indirect emissions that accounts for greenhouse gas emissions from the generation of purchased energy products (principally, electricity, steam/heat and reduction materials used for smelting) by the entity.

Scope 2 in relation to the existing TIPS and BIPS covers purchased electricity defined as electricity that is purchased or otherwise brought into the organisational boundary of the entity. Scope 2 emissions physically occur at the facility where electricity is generated. Entities report the emissions from the generation of purchased electricity that is consumed in its owned or controlled equipment or operations as Scope 2.

In the context of this GHGA, electricity output has been calculated net of electricity consumed auxiliary plant, noting that some element of the TIPS and BIPS plant would be on line except in extremely rare events. On this accounting basis, Scope 2 emissions do not form part of the scope of this analysis.

3.1.1.3 Scope 3: Other Indirect Greenhouse Gas Emissions

Scope 3 emissions are defined as those emissions that are a consequence of the activities of an entity, but which arise from sources not owned or controlled by that entity. Some examples of Scope 3 activities provided in the GHG Protocol are extraction and production of purchased materials, transportation of purchased fuels, and use of sold products and services. In the case of BIPS, Scope 3 emissions will include emissions associated with fuel cycles.

The GHG Protocol provides that reporting scope 3 emissions is optional. If an organisation believes that Scope 3 emissions are a significant component of the total emissions inventory, these can be reported along with Scope 1 and Scope 2. However, the GHG Protocol notes that reporting Scope 3 emissions can result in double counting of emissions and can also make comparisons between organisations and/or products difficult because reporting is voluntary.

Double counting needs to be avoided when compiling national (country) inventories under the Kyoto Protocol. The GHG Protocol also recognises that compliance regimes are more likely to focus on the “point of release” of emissions (i.e. direct emissions) and/or indirect emissions from the purchase of electricity.

Under the NGER Act, facilities triggering greenhouse emission and energy usage thresholds are required to report Scope 1 and Scope 2, but not Scope 3.

3.2 National Greenhouse and Energy Reporting (Measurement) Determination 2008

The National Greenhouse and Energy Reporting (Measurement) Determination 2008 (the NGER Determination) commenced on 1 July 2008 and is made under subsection 10 (3) of the NGER Act. It provides a framework for the measurement of the following arising from the operation of facilities:

- Greenhouse gas emissions.
- The production of energy.
- The consumption of energy.

The determination addresses Scope 1 and Scope 2 emissions. The methods are presented in a tiered structure with higher tiers producing less uncertain results but requiring more data to employ. In the NGER Determination there are 4 categories of Scope 1 emissions (the code for the IPCC classification is provided in brackets):

- Fuel combustion (UNFCCC Category 1.A).
- Fugitive emissions from fuels, which deals with emissions released from the extraction, production, flaring of fuel, processing and distribution of fossil fuels (UNFCCC Category 1.B).
- Industrial processes emissions (UNFCCC Category 2).
- Waste emissions (UNFCCC Category 6).

It is acknowledged that as the NGER Guidelines are derived from the NGER Determination, where there is a perceived contradiction between the NGER Guidelines and NGER Determination, the NGER Determination has taken precedence.

3.3 Assessment approach

GHG emissions have been estimated for the Project and the existing TIPS facilities based upon the methods outlined in the following documents:

- The National Greenhouse and Energy Reporting (Measurement) Amendment Determination 2008.
- Site specific information.
- The NGER Guidelines.
- The NGA Factors.

4 Emission Inventory

4.1 Assessment scenarios

The estimation of greenhouse gas emissions requires an understanding of the generating loads and frequency of operation at which the Project will operate. In constructing assessment scenarios within this GHGA, a consideration of existing and proposed generation technologies has been made in a manner that recognises the interaction between the TIPS and BIPS.

The TIPS currently operates in the National Electricity Market (NEM), generating power on a variable basis in accordance with market conditions. With the development of the Project, and subsequent mothballing of the 400 MW TIPS A Station, it is anticipated that the total generation capacity of the Torrens Island generating infrastructure will not change significantly, rather it is expected that the newer plant will to a large extent displace the existing plant, with a potential increase in operating duty, and a significant reduction in fuel consumption and greenhouse gas emissions associated with maintenance and preparation of plant to generate power. There will also be a significant improvement in the greenhouse gas efficiency of the collective TIPS / BIPS generation infrastructure, especially with respect to the efficiency with which the plant is able to respond to fluctuating in network demand.

AGL have prepared estimates of annual fuel consumption and electricity generation for two separate emission scenarios. These are:

- **Scenario 1:** Forecasted Operations – Stage 1 + TIPS B (typical operations).
- **Scenario 2:** BIPS Maximum Share – Stage 1 + TIPS B (BIPS operation prioritised).

Scenario 1 represents forecasted operations based on AGL's current understanding of the electricity market conditions, and the anticipated interaction between the BIPS and TIPS in fulfilling market demand.

Scenario 2 represents an adaptation of Scenario 1, in which the BIPS operation is prioritised such that TIPS operation is primarily limited to cases where the combined TIPS/BIPS output is in excess of the capacity of that offered by the BIPS alone.

Table 4-1: Summary of estimated fuel consumption and electricity output

Scenario	Estimated Fuel Consumption (PJ)		Estimated Electricity Output* (GWh)
	Natural Gas	Diesel	
Scenario 1: Forecasted Operations	15.9	0.16	1,409
Scenario 2: BIPS Maximum Share	20.1	0.16	1,865

Note - PJ: Petajoule = 1 x 10^{15} Joules. GWh: Gigawatt hour. *Electricity output estimate includes an allowance for electricity consumed on site by auxiliary plant items.

It is noted that estimates of electricity output have accounted for electricity consumption associated with auxiliary plant. In addition, given the uncertainty around implementation of Stage 2, emission estimates have not been undertaken for this plant.

4.2 GHG emission factors

GHG emission factors have been compiled for Scope 1 and Scope 3 emissions associated with natural gas and diesel fuel combustion.

AGL have provided a site-specific NGER Guideline (Method 2) calculated Scope 1 emission factor for natural gas combustion, as determined from the balance and speciation of natural gas combusted at TIPS during 2016/2017. The Scope 1 diesel emission factor has been sourced from Section 2.41 of the NGER Guidelines.

The Scope 3 emission factor for natural gas combustion has been sourced from Table 37 of the NGA Factors (Scope 3 emission factor for natural gas combustion in South Australia (Metro). The Scope 3 greenhouse gas emission factor for diesel combustion in South Australia of 3.6 kg CO_2-e/GJ has been sourced from Table 39 of the NGA Factors.

Table 3-1 provides a summary these factors for natural gas and diesel fuels.

Table 4-2: Summary of Adopted Emission Factors

Emission Type	Adopted Emission Factors (kg CO_2-e / GJ)		
	Scope 1	Scope 3	Scope 1+3
Natural Gas	50.91 [(1)]	10.4 [(3)]	61.3
Diesel	70.2 [(2)]	3.6 [(4)]	73.8

Source: [(1)] AGL
[(2)] DoE (2015) Section 2.41
[(3)] DoEE (2016b) Table 37
[(4)] DoEE (2016b) Table 39.

4.3 Emission estimates

The fuel consumption estimates (see Scenario 1 represents forecasted operations based on AGL's current understanding of the electricity market conditions, and the anticipated interaction between the BIPS and TIPS in fulfilling market demand.

Scenario 2 represents an adaptation of Scenario 1, in which the BIPS operation is prioritised such that TIPS operation is primarily limited to cases where the combined TIPS/BIPS output is in excess of the capacity of that offered by the BIPS alone.

Table 4-1) have been combined with the relevant emission factors (see Table 4-2) to calculate the Scope 1 and Scope 3 emissions for each emission scenario. Table 4-2 presents a summary of these estimates.

Table 4-3: Summary of estimated GHG emissions – Scenario 1: Forecasted Operations

Scenario	Estimated GHG Emissions (kt CO_2-e)		
	Natural Gas Combustion	Diesel Combustion	**Total**
Scope 1	819	11	**830**
Scope 3	165	0.6	**166**
Scope 1 + 3	984	12	**996**

Note: totals may appear non-additive due to rounding.

Table 4-4: Summary of estimated GHG emissions – Scenario 2: BIPS Maximum Share

Scenario	Estimated GHG Emissions (kt CO_2-e)		
	Natural Gas Combustion	Diesel Combustion	Total
Scope 1	1,033	11	**1,045**
Scope 3	209	0.6	**209**
Scope 1 + 3	1,242	12	**1,254**

Note: totals may appear non-additive due to rounding.

The Scope 1 emissions would be 830 kt CO_2-e and 1,045 kt CO_2-e and for Scenario 1 and Scenario 2 respectively.

5 National Benchmarking

The most recent inventory data available for Australia are published in the *Quarterly Update of Australia's Greenhouse Gas Inventory: June 2016* (DoEE, 2016a). Australia's annual total emissions for the year to June 2016 are estimated to be 536.5 Mt CO_2-e.

Table 2 5: Australian's 'unadjusted' GHG Emissions by Sector

Sector	Year to June 2016 (Mt CO_2-e)
Energy – Electricity	189
Energy – Stationary energy excluding electricity	98.2
Energy – Transport	93.4
Energy – Fugitive emissions	40.7
Industrial processes and product use	34.1
Agriculture	67.3
Waste	12
National Inventory Total (excluding Land Use, Land Use Change and Forestry)	***534.7***
Land Use, Land Use Change and Forestry	1.7
National Inventory Total (including Land Use, Land Use Change and Forestry)	***536.5***

Source: (DoEE, 2016a).

The overall contribution of the Stage 1 BIPS and TIPS operation (Scope 1 and Scope 3) would be 0.19% and 0.23% of national emissions for Scenarios 1 and 2 (respectively). It is noted that a large proportion of these emissions would not be additional given that the existing TIPS operation has been included within accounting totals.

6 Greenhouse gas management measures

AGL is committed to complying with all mandatory government programs and is a voluntary participant in Federal and State government greenhouse gas reduction programs.

Maximum gains in efficiency, and thus GHG management, can be realised through the choice of best available power generation technology. Less significant efficiencies and greenhouse gas reductions can be realised through operational management and maintenance practices, some of which are presented in the following sections.

6.1 Engineering Considerations

Ensure the layout of the site is well considered:

- Avoiding the location of sources of waste heat near reciprocating engine inlets.
- Due consideration of prevailing meteorology in the layout of the site.

6.2 Operational Considerations

Efficient performance in service will be reliant upon correct maintenance of equipment and the culture of its operation. Key issues to consider:

- Maintenance and operational culture focused on optimisation and efficiency.
- Development of strong performance indicators based around plant efficiency and greenhouse intensity.
- Prevention of fugitive releases of natural gas where this can be done safely.

7 Conclusion

Pacific Environment has been commissioned to undertake a Greenhouse Gas Assessment for a proposed power station development at Torrens Island in South Australia.

The Project's GHG emissions are associated with combustion of fuels in reciprocating engines. Scope 1 and Scope 3 greenhouse gas emissions for the Project were estimated for two operational scenarios, using national greenhouse gas emission estimation methodologies. AGL provided estimates of fuel consumption that recognise the interaction between the TIPS and BIPS.

The Scope 1 emissions of 830 kt CO_2-e and 1,045 kt CO_2-e have been estimated for Scenario 1 and Scenario 2 respectively. The overall contribution (Scope 1 and Scope 3) of the Stage 1 BIPS and TIPS operation would be 0.19% and 0.23% of national emissions for Scenarios 1 and 2 (respectively). It is noted that a large proportion of these emissions would not be additional given that TIPS emissions have been included within accounting totals.

AGL propose to employ a number of mitigation measures at the Project site to minimise the generation of GHG emissions. Such measures will include engineering and operational considerations.

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Appendix J

Environmental noise assessment

Barker Inlet Power Station

Environmental Noise Assessment

September 2017

sonus.

Chris Turnbull
Principal
Phone: +61 (0) 417 845 720
Email: ct@sonus.com.au
www.sonus.com.au

Sonus Pty Ltd
17 Ruthven Avenue
Adelaide 5000 SA
www.sonus.com.au

sonus.

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Date	September 2017
Author	Chris Turnbull, MAAS
Reviewer	Jason Turner, MAAS

TABLE OF CONTENTS

GLOSSARY

A-weighting	Frequency adjustment applied to measured noise levels to replicate the frequency response of the human ear.
CONCAWE	The oil companies' international study group for conservation of clean air and water - Europe, The propagation of noise from petrochemical complexes to neighbouring communities (May 1981).
Day	The period between 7am and 10pm.
dB	Un-weighted (or linear) noise or sound power level in decibels.
dB(A)	A-weighted noise or sound power level in decibels.
Equivalent noise level	Energy averaged noise level.
L_{eq}	Equivalent noise level
Night	The period between 10pm and 7am.
Sound power level	A measure of the total sound energy emitted from a source of noise.
Weather category 6	Weather category which is most conducive for the propagation of noise, resulting in highest predicted noise levels when using CONCAWE.
Worst-case	Conditions resulting in the highest noise level at residences.

1 INTRODUCTION

Sonus has conducted an environmental noise assessment of the proposed Barker Inlet Power Station (BIPS) located adjacent to AGL's existing Power Station on Torrens Island.

The proposed BIPS comprises 2 stages, each with 12 reciprocating engines. The conceptual layout of the BIPS is provided in Appendix A.

The closest residences to the BIPS are located to 1.5km the west (on the opposite side of the Port Adelaide River) on Mersey Road, Taperoo.

This report assesses the operational noise from the proposed BIPS against the relevant criteria of the *Environment Protection (Noise) Policy 2007* and is based on:

- The following drawings:
  - "DBAE540099" dated 18 August 2017;
  - "DBAE540100" dated 23 August 2017;
  - "DBAE540101" dated 17 August 2017;
  - "DBAE541351" dated 18 August 2017; and,
- The noise data for the Wartsila "W18V50DF" summarised in document "DBAE543660"

2 EXISTING ACOUSTIC ENVIRONMENT

To provide a measure of the existing acoustic environment at the closest residences to the BIPS, noise levels were continuously monitored on Mersey Road at a location representative of the closest residences, between 25 and 31 August 2017.

A graph of the background ($L_{90, 15minute}$) noise levels logged during this period are presented as Appendix B.

The noise monitoring results indicate that the noise in the area is intermittently influenced by traffic, meteorological conditions and industry, with periods where the background noise was higher than 50 dB(A) but other periods where the noise was less than 35 dB(A).

3 CRITERIA

The proposed BIPS is located within a Public Purpose Zone of Land Not Within a Council Area Development Plan, while the nearest residences are located on the western side of Mersey Road, Taperoo, within a Residential Zone of Port Adelaide Enfield City Development Plan.

To provide an objective assessment of the noise from the operation of the proposed BIPS, reference is made to the *Environment Protection (Noise) Policy 2007* (the Policy). The Policy provides objective criteria for the assessment of environmental noise which are based on the World Health Organisation Guidelines to prevent annoyance, sleep disturbance and unreasonable interference on the amenity of an area.

The Policy establishes goal noise levels (L_{eq}) to be achieved at the noise receivers (dwellings), based on the Development Plan locality in which the noise source (BIPS) and the noise receivers are located, the land use that these localities principally promote, and the ambient environment.

Where the Development Plan locality in which the noise source and the noise receiver are separated by more than 100m (with an intervening locality between), the goal noise levels of the Policy are based only on the principally promoted land use of the noise receiver. For the proposed site, the Port Adelaide River is considered to be an intervening locality separating the residences from the site.

Based on Development Plan localities and presence of an intervening locality (Port Adelaide River) greater than 100m, the Policy defines the criteria based on the receiving (Residential) zone alone. The goal noise levels are as follows:

- an average noise level ($L_{eq,15min}$) of 47 dB(A) during the day (7am until 10pm); and,
- an average noise level ($L_{eq,15min}$) of 40 dB(A) during the night (10pm until 7am).

The BIPS will potentially operate at any time during the day or night. Therefore, given that the existing acoustic environment at the closest residences does not allow the above criteria to be relaxed, the “night” goal noise level of 40 dB(A) is the most relevant criterion for operation of the BIPS.

In addition to the above, when measuring or predicting noise levels for comparison with the goal noise levels of the Policy, adjustments are made for any dominant characteristic of tone, low frequency, modulation or impulsiveness. 5 dB(A) is added if one characteristic is present, 8 dB(A) is added for two characteristics and 10 dB(A) is added for three or four characteristics. To apply a penalty, the characteristic must be dominant when considered within the context of the existing acoustic environment at the noise receivers.

4 ASSESSMENT

4.1 Noise Prediction Model

Noise predictions have been made using the CONCAWE[1] noise propagation model and SoundPLAN noise modelling software. The sound propagation model considers the following influences:

- sound power levels and locations of noise sources;
- separation distances between noise sources and receivers;
- topography of the area;
- influence of the ground;
- air absorption; and,
- meteorological conditions.

The CONCAWE system divides meteorological conditions into six separate "weather categories", depending on wind speed, wind direction, time of day and level of cloud cover. Weather Category 1 provides the weather conditions associated with the "lowest" propagation of noise, whilst Weather Category 6 provides "worst-case" (i.e. highest noise level) conditions. Weather Category 4 provides "neutral" weather conditions for noise propagation (that is, conditions which do not account for the effects of temperature inversion or wind on propagation).

The assessment has been conducted based on worst-case (Weather Category 6) conditions. Such conditions are most likely to occur on a clear night with a light breeze from the Project to the residences.

4.2 Noise Sources

This assessment has considered 24 engines and associated equipment, which are proposed to be part of Stage 1 and 2. There are currently multiple manufacturers being considered as part of the tender process. This assessment has considered the combined operation 24 Wartsila "W18V50DF" engines. A final assessment will be made to confirm compliance with the project criteria when the final equipment selections are made.

The data provided by Wartsila accounts for engines that incorporate noise attenuation measures such as air intake and exhaust silencers and enclosures. The noise data used for the environmental noise assessment is summarised in Table 1 below.

---

[1] CONCAWE - The oil companies' international study group for conservation of clean air and water – Europe, 'The propagation of noise from petrochemical complexes to neighbouring communities', May 1981.

Table 1: Noise data for each component of the BIPS

Noise Source/Element	Number/Length of Noise Sources per Stage	Noise Descriptor	Sound Level/Transmission Loss in band octave centre frequencies									Overall Noise Level	
			31.5 Hz	63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz	Total (dB)	Total (dB(A))
Noise Level within Engine Hall	-	Sound pressure level, L_p, (dB re 20µPa)	96	102	100	101	103	102	104	104	98	111	110
Transmission Loss of Engine Hall Steel Sandwich Panel	-	Transmission Loss (dB)	8	14	20	26	32	36	30	48	58	-	-
Exhaust gas outlet with silencer + SCR	12	Sound power level, L_w, (dB re 1pW)	125	113	105	94	84	78	79	90	0	125	95
Insulated exhaust gas duct	700m	Sound power level, L_w, (dB/m re 1pW)	63	71	70	76	85	91	79	79	66	93	92
Charge air intake with silencer	24	Sound power level, L_w, (dB re 1pW)	116	112	99	79	71	85	84	84	94	118	96
Ventilation intake	24	Sound power level, L_w, (dB re 1pW)	100	95	96	87	85	80	78	72	66	103	87
Ventilation outlet roof monitor	115m	Sound power level, L_w, (dB/m re 1pW)	114	109	109	108	103	96	99	94	82	117	106
Gas pressure reduction station	1	Sound power level, L_w, (dB re 1pW)	-	-	-	-	72	84	91	93	93	97	98
Low noise 7-fan cooling radiator	48	Sound power level, L_w, (dB re 1pW)	115	102	99	101	100	98	95	92	91	115	103

4.3 Predicted Noise Level

The noise level at the nearest residences (on the western side of Mersey Road) have been predicted for the continuous operation of the proposed BIPS based on the above sound power levels and worst-case weather conditions and “BIPS Option 1” layout (as detailed in Appendix A).

The predictions indicate that the noise levels at the nearest residences would be 52 dB(A) based on the manufacturer’s data for the engines with standard inlet and exhaust silencers and enclosures, which exceeds the requirements of the Policy. To achieve the criterion of 40 dB(A), the additional noise attenuation provided in Table 2 would be required.

Table 2: Noise Attenuation Recommendations

Noise Source	Minimum Level of Noise Attenuation Required (dB)								
	31.5 Hz	63 Hz	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz
Insulated exhaust gas ducting	0	0	0	0	7	15	0	0	0
Ventilation outlet roof monitor	0	7	16	24	27	22	19	0	0
Low noise 7-fan cooling radiator	0	0	0	2	9	9	0	0	0

With the above attenuation incorporated in the design, the noise level at the nearest residences is predicted to be 40 dB(A). The results of the predictions are shown in Figure 1 below. Figure 1 also shows the location of the closest residences and noise monitoring location.

Some of the equipment proposed for the BIPS will have audible tonality in close proximity, although there is not expected to be any penalty warranted for noise characteristics at the surrounding residences given the masking effect of the more dominant broadband noise sources, and the relatively low level of noise compared with the typical noise in the environment.

Figure 1: Noise Predictions

5 CONCLUSION

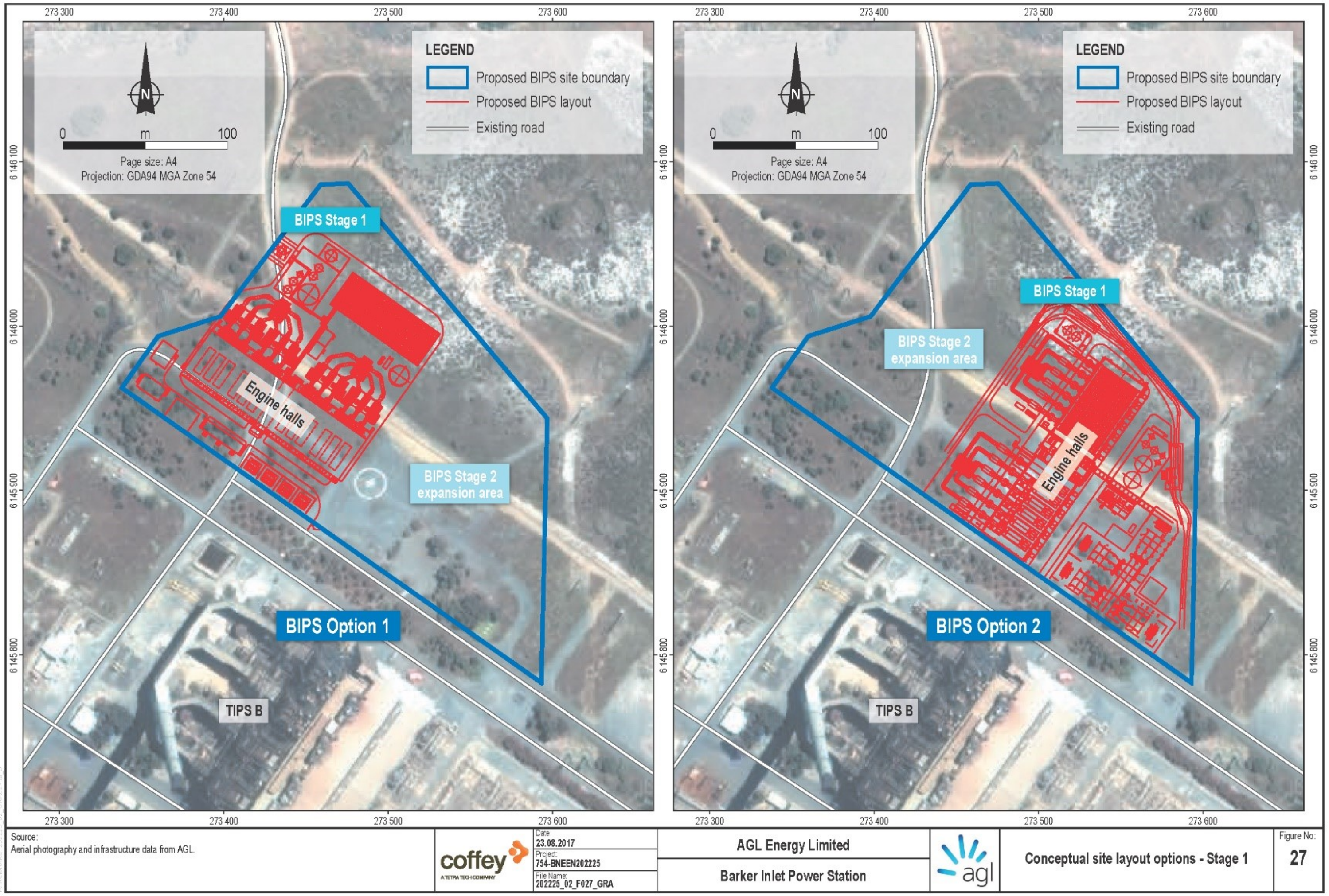
An environmental noise assessment has been made of the proposed Barker Inlet Power Station.

The assessment considers noise at the closest residences from the combined operation 24 Wartsila "W18V50DF" engines and associated equipment

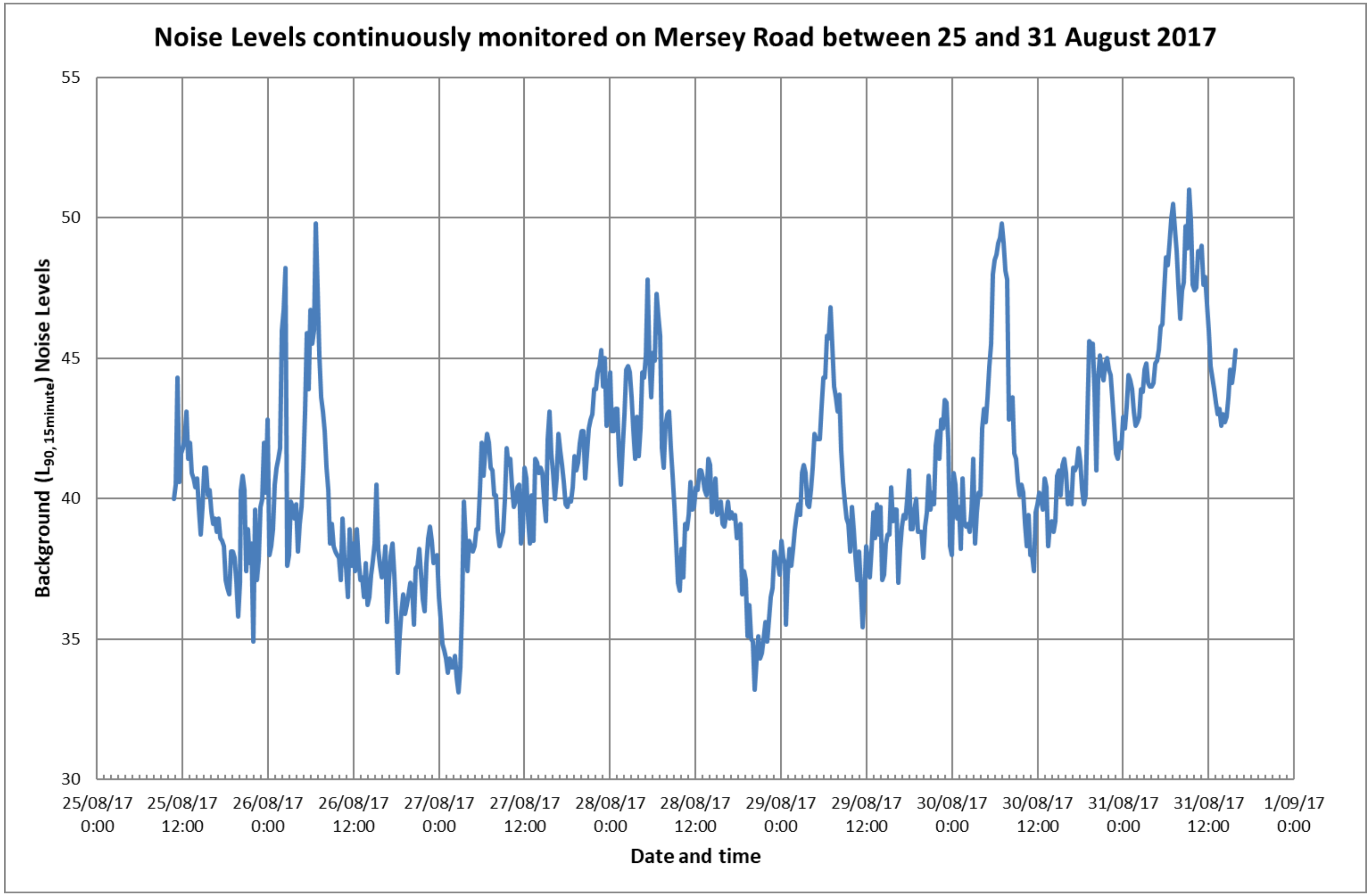
Noise predictions have been compared against criteria developed in accordance with the *Environment Protection (Noise) Policy 2007*.

Based on the predictions, the requirements of the *Environment Protection (Noise) Policy 2007* can be achieved with the incorporation of noise attenuation measures detailed in this report. Noise attenuation measures will need to be incorporated in the final equipment design and an updated noise assessment can be made to confirm compliance with the project criteria once the equipment selections are finalised.

APPENDIX A: Conceptual layout of the BIPS



APPENDIX A: Existing Acoustic Environment



Appendix K

Surface water and groundwater assessment

SURFACE WATER AND GROUNDWATER ASSESSMENT FOR THE TORRENS ISLAND POWER STATION (TIPS) PROPOSED EXPANSION TORRENS ISLAND

Prepared for:

AGL Energy Limited
Level 22, 101 Miller St
North Sydney NSW 2060

Report Date: 22 December 2009
Project Ref: NSYSWAYV05041AA

Written/Submitted by:

Meredith Rasch
Environmental Scientist

Written/Submitted by:

David Tully
Principal

Coffey Environments Australia Pty Ltd ACN 140 765 902
Level 1, 2-3 Greenhill Road Wayville SA 5034 Australia
T +61 8 7221 3500 F +61 8 8172 1968 coffey.com

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CONTENTS

CONTENTS

LIST OF ATTACHMENTS

In-text Tables

Figures

Appendices

ABBREVIATIONS

ANZECC	Australian and New Zealand Environment and Conservation Council
bgs	below ground surface
BH	Borehole
DWLBC	Department of Water Land and Biodiversity Conservation (SA)
ESA	Environmental Site Assessment
ID	Identification
IP	Interface Probe
LOR	Limit of Reporting
µg/L	micrograms per litre
mg/L	milligrams per litre
MW	Monitoring Well
NATA	National Association of Testing Authorities
NEPM	National Environment Protection Measure
Ppm	parts per million
ppmv	parts per million by volume
SA EPA	South Australian Environment Protections Authority
SA EPP	South Australian Environment Protection Policy
SB	Soil Bore
SPH	Separate Phase Hydrocarbon
SWL	Static Water Level
TD	Total Depth
TDS	Total Dissolved Solid
TOC	Top of Casing

1 INTRODUCTION

1.1 Background

AGL Energy Limited (AGL) has engaged Coffey Environments Pty Ltd to assist in environmental and social permitting of a proposed Energy Park at the Torrens Island Power Station, near Adelaide, South Australia (SA). AGL is proposing to develop an Energy Park at Torrens Island.

AGL currently proposes the Energy Park to consist of the following components:

- Liquefied natural gas (LNG) production plant, LNG storage tank and re-gasification units.
- Power station expansion (gas turbine peaking plant).

Some of these components may vary according to future needs.

1.2 Project Description

AGL is the owner and operator of the Torrens Island Power Station (TIPS). The power station was constructed between 1963 and 1981 and was purchased by AGL in July 2007. TIPS currently comprises two gas fired power stations with a generating capacity of 1,280 MW from eight units. The power station is fuelled with natural gas supplied via the SEAGas pipeline from Victoria and via the Moomba to Adelaide pipeline (MAP).

AGL is investigating the feasibility of expanding its existing facilities at the TIPS site to create an Energy Park that will allow for progressive development of a series of energy based projects. The currently proposed components of the Energy Park are described in the following sections.

1.2.1 Energy Park Components

LNG Storage and Production Facility

The LNG storage facility would receive natural gas from a pipeline (either SEAGas or MAP), cool and liquefy the gas and store it in a cryogenic tank on site for use when required. The LNG tank would be approximately 50 m in diameter and 35 m high with capacity for 20,000T of LNG.

The stored LNG may be used in the following ways:

- Electricity generation - re-gasify LNG and transfer to TIPS during peak demand.
- Gas supply - re-gasify LNG and transfer natural gas to the pipeline network for sale in SA.
- Security of supply - re-gasify LNG for either power generation or transfer to the SA gas distribution network in time of supply disruption.
- LNG supply - transfer to road tanker for sale to market as an alternative, lower carbon intensity fuel for heavy duty trucks or remote power generation.

Power Station Expansion

The future expansion of TIPS will be in the form of new open cycle gas turbines in addition to the existing power stations. The total expanded capacity could be in the order of 2,000 MW, of which 480 to 800 MW would be from the proposed new turbines.

The final mix and type of new installed capacity is still to be determined and a number of options are being evaluated including peaking generation of:

- Up to four units of 120-190MW each or;
- Two units of 240-300MW each.

The timing of the expansion is subject to market demand and is therefore still to be determined. Construction is expected to commence within the next five years.

1.3 Study Area

The Energy Park will be located adjacent to the existing TIPS on Torrens Island, 15 km northwest of the Adelaide CBD. Torrens Island is connected to the mainland by the Grand Trunkway Bridge over the North Arm to Garden Island and a causeway between Garden and Torrens Islands. The proposed site is zoned as Public Purpose (Power Station) under the 'Land Not Within a Council Area (Metropolitan) Development Plan 2009', with the proposed expansion being a permissible use under this plan. Additionally the proposed site is not within the local council's jurisdiction.

The study area includes all areas that may be affected by the proposed Energy Park.

1.4 Objectives

The purpose of the geology, surface and groundwater study was to:

- Characterise the geology in the study area.
- Characterise the existing surface water hydrological environment in the study area.
- Characterise the existing nature and quality of groundwater in the study area.
- Identify and describe any potential impacts on surface water or groundwater as a result of the proposed project.
- Propose measures to avoid, minimise, or, where appropriate, mitigate adverse impacts on surface and groundwater quality and, where appropriate, to manage residual impacts.

1.5 Scope of Work

The scope of work comprised:

- Reviewing available information regarding geology, surface hydrology, hydrogeology and groundwater quality within the study area and surrounding area.
- Characterisation of the existing hydrological environment in the study area including a description of the nature, quality, and processes and land uses affecting stormwater, the river system, ephemeral wetlands and the surrounding marine environment.
- Characterising the nature and quality of the groundwater in the study area, including description of the nature, quality and processes affecting local hydrogeology and water quality, and existing groundwater uses.
- Providing recommendations on monitoring and reporting programs, if required to enable sound water quality management.
- Preparing a concise stand-alone report.

2 GEOLOGY

2.1 Regional Geology

The Adelaide 1:250,000 scale S.A. Geological Atlas Series Sheet SI 54-9 zones 5 & 6 (Department of Mines Adelaide, 1969) indicates that the regional geology is composed predominantly of Holocene age marine sands and muds of the St Kilda Formation.

In the study area the St Kilda Formation can be described as light-grey shelly stranded beach ridge deposits and shelly silts and sands overlain in places by modern intertidal and swamp deposits. Figure 1.

The Holocene age landforms overlie older Pleistocene clays (Pooraka and Hindmarsh Formations) and in parts there is a discontinuous Bakara Calcrete horizon associated with the Glanville Formation which underlies the Pooraka Formation. From a review of previous studies at Gillman, LeFevre Peninsula sites and Torrens Island the Glanville Formation has been identified in drill cores or inferred from push cores at these locations.

Hindmarsh Clay has been intersected in previous studies at a depth of approximately 10 m below the natural surface. The Hindmarsh Clay is approximately 70 m in thickness in the Adelaide Plains region and is generally considered a good aquitard between surface Quaternary aquifers and lower Tertiary aquifers.

2.1.1 Acid Sulphate Soils

Adjacent to the western and north western boundary of the current TIPS site is an area of potential acid sulphate soils (mangrove and tidal stream) which are identified in the Government of South Australia, (2009) “Atlas of South Australia” (Figure 2). Further investigation may be required to assess the impact on proposed future structures.

2.2 Site Specific Geology

Details regarding the site specific geology were obtained from bore logs provided in the Torrens Island Power Station Site Contamination Test Report (BRW, 2000) for bore hole drilling on the TIPS site. The maximum depth of investigation was 4.5 metres below ground surface (mbgs).Fill material (consisting of sand and gravel) ranging to a depth of 0.25 mbgs to 2.5 mbgs was found overlying fine grained brown and light brown sand. This is consistent with the St Kilda Formation.

3 SURFACE WATER

3.1 General Description

Surface water in the study area has been identified as:

- Mangrove swamps and ephemeral wetlands within Torrens Island.
- Waterways including Angas and Barker inlets, the North Arm and the Port Adelaide River.
- Areas of stormwater collection.

3.2 Applicable Environmental Values

The South Australian Environment Protection Authority (SA EPA) has developed an ‘Environment Protection (Water Quality) Policy (EPP)’ for South Australia’s inland (surface and underground), estuarine and marine waters based on the National Water Quality Management Strategy (ANZECC/ARMCANZ, 2000). These protected environmental uses for South Australian surface waters (and underground waters) (SA EPA, 2003) are:

- Maintenance of aquatic ecosystems, fresh and marine.
- Recreation and aesthetics.
- Potable water use.
- Agriculture (irrigation and livestock drinking water)/aquaculture.
- Industrial use.

The SA EPA have developed specific environmental water quality objectives for the Port Waterways in the Port Waterways Water Quality Improvement Plan (WQIP) (SA EPA, 2008). The plan details strategies for water quality improvement for nutrient levels in the Port Waterways. The plan considers the range of nutrient inputs to the area and has enabled stakeholders to agree on outcomes and the processes for achieving them.

The waterways surrounding TIPS study area are included in the ‘Central Barker Inlet Segment’ (as defined by the SA EPA WQIP (SA EPA, 2008)) which includes SA EPA ambient water quality monitoring locations 2,4,5,6 and 7. (Refer Figure 3). The Barker Inlet is a water way on the eastern side of Torrens Island. The water quality objectives for nutrients in this segment are tabulated in Table 3.1:

Table 3.1 Water Quality Objectives for Nutrients

Nutrient	Value
Chlorophyll α	1 µg/L
Total Phosphorous	25 µg/L
Filterable Reactive Phosphorous	10 µg/L
Total Nitrogen	230 µg/L
Nitrate and Nitrate (as Nitrogen)	5 µg/L
Ammonia (as Nitrogen)	10 µg/L

At the time of publication of the WQIP, two major sources of nutrients discharge into the Port Waterways were identified as Penrice Soda Products and Bolivar Waste Water Treatment Plant. At present the TIPS operation does not and is not likely to impact on WQIP environmental values targets unless there are changes in the operational methodology.

3.3 Ephemeral Wetlands within Torrens Island

3.3.1 General Description

Numerous small ephemeral tidal lakes and creeks are present within the area of mangroves surrounding the study area. The study area is composed of a marine environment which consists of low-lying dunes and Chenier ridges (a ridge formed by the lateral transport and reworking of deltaic sediments, usually containing large amounts of shell deposits), supratidal flats, intertidal mangrove woodlands, intertidal mud and sand flats and possible tidal channels. Water from these bodies flows either into the waterways located around Torrens Island or will filter through the soil into the groundwater.

3.3.2 Current Uses and Environmental Values

Wetlands and waterways surround the TIPS study area. The current land and waterways adjacent to the TIPS study area are:

- To the north-west – mangrove swamps adjacent to the site boundary;
- To the north – degraded natural scrubland with evidence of an aquaculture facility approximately 600m from the site boundary; and
- To the north-east – degraded natural scrubland beyond which is natural scrubland approximately 300m from the site boundary.
- To the east – a small band of native scrubland beyond which is Angas Inlet
- To the south – the junction of Angas Inlet and North Arm
- To the west – a small band of native scrubland beyond which is the Port Adelaide River

As the dominant surface water present is either the Port Waterways and ephemeral tidal lakes and creeks, the most relevant protected environmental values for these waters, which are estuarine and marine, would be the SA EPP (2003) Water Quality Criteria for Maintenance of aquatic ecosystems - marine.

3.3.3 Water Quality

No information regarding surface water quality has been identified for the ephemeral wetlands in the site vicinity and was not established as part of this investigation.

3.3.4 Potential Impacts

The most likely pollution sources to cause potential impacts to the ephemeral wetlands are spills of contaminating liquids utilised on the site (such as petroleum products and chemicals) into creeks or lakes.

There is potential for stormwater to contact contaminated soil or across any contaminated hardstand before entering the ephemeral waterways and this may change the composition of water in these areas.

3.4 Waterways

3.4.1 General Description

The waterway surrounding the study area is the Central Barker Inlet Segment which includes the Port Adelaide River, North Arm Creek, Barker Inlet and Angas Inlet (see Figure 3). Angas Inlet and North Arm -Port Adelaide River lie adjacent to the south eastern and south western boundaries of the TIPS site respectively. Cooling water for the power station is currently extracted from the North Arm and discharged into Angas Inlet.

3.4.2 Current Uses and Environmental Values

Current uses of the Central Barker Inlet Segment (SA EPA, 2005) include:

- Recreational uses including swimming, boating, fishing;
- Primary production use including collection of shellfish and fish for human consumption;
- Aesthetic use as an ecosystem for dolphin and fish breeding; and.
- Industrial use as a source of cooling water for power stations.

The protected environmental values would therefore include the SA EPA Water Quality Criteria for:

- Maintenance of aquatic ecosystems – marine;
- Primary industries for aquaculture and consumption of aquatic foods
- Recreation and aesthetics; and
- Industrial use (cooling water for power stations).

As this region falls within the area set by the SA EPA for the Port Waterways WQIP, the guidelines for nutrient levels are to be considered for any discharges into the waterways.

3.4.3 Water Quality

The SA EPA has selected several substances or conditions (called water quality indicators) dependent on the substance or condition that may be affecting water quality in an area and the environmental values observed to exceed the Australian Water Quality Guidelines. Excessive nutrients (which increase algal blooms and aquatic plant growth to undesirable levels) have been identified in the Port Waterways region as a serious pollutant. Nutrient indicators selected by the SA EPA include total nitrogen , ammonia , oxidised nitrogen, nitrate , nitrite , total phosphorus and soluble phosphorus. Other indicators selected by the SA EPA indicating non-nutrient related water quality parameters include turbidity, heavy metals, bacteria and chlorophyll (a).

The results of these analyses are compared with the National Water Quality Guidelines or with the Australian Drinking Water Guidelines. These guideline values are considered to be the upper acceptable limit for each indicator and allow the SA EPA to classify the water as good, moderate or poor quality, depending on whether it is below, meets or exceeds the guidelines.

The SA EPA has reported nutrient monitoring results in this vicinity since 1995. The two nearest SA EPA sampling points on waterways with direct contact to the current TIPS site are Site 4 and Site 6 while Site 1 (incorporated in the Southern Segment) is closest to some parts of the proposed development area (refer Figure 3). The water quality parameters for the most recent data posted at these sites by the SA EPA (April to September 2006) are tabulated in Table 3.2and 3.3 below. The results from Site 4 and Site 6 are identical and have been reported in Table 3.2.

A plan showing all the SA EPA sample locations within the Port Waterways is contained in Figure 3.

Table 3.2 Site 4– Port Adelaide River - Western End of Angas Inlet and Site 6 - Torrens each - Eastern End of Angas Inlet

Indicator	Ecosystem	Recreation	Aquaculture
Ammonia	Poor	NA	Good
Oxidised Nitrogen	Poor	NA	NA
Total Nitrogen	Moderate	NA	NA
Soluble Phosphorus	Good	NA	NA
Total Phosphorus	Good	NA	NA
Turbidity	Good	Good	NA
Chlorophyll a	Poor	NA	NA
Heavy Metals	Poor	NA	Good
Bacteria	NA	Good	Good

Note: NA – not applicable.

Table 3.3 Site 1 – Port Adelaide River – South of Port Adelaide and North Arm Junction

Indicator	Ecosystem	Recreation	Aquaculture
Ammonia	Poor	NA	Good
Oxidised Nitrogen	Poor	NA	NA
Total Nitrogen	Good	NA	NA
Soluble Phosphorus	Good	NA	NA
Total Phosphorus	Good	NA	NA
Turbidity	Good	Good	NA
Chlorophyll a	Poor	NA	NA
Heavy Metals	Poor	NA	Good
Bacteria	NA	Good	Good

Note: NA – not applicable

(Tables 3.2 and 3.3 taken from the SA EPA Website http://www.epa.sa.gov.au/nrm_map_port.html)

Ammonia, oxidised nitrogen and chlorophyll (a) were all classified as poor at Sites 1, 4 and 6 and total nitrogen was also elevated at Sites 4 and 6. Potential of pollutant sources related to these reduced levels of water quality include industrial discharges and the large number of stormwater drains that discharge into the Port Waterways. No effects from the TIPS operation was noted by the SA EPA.

Heavy metals were classified as poor (copper and zinc) at Sites 1, 4 and 6, which according to the SA EPA (2009b) are most likely due to urban runoff containing heavy metals washing off roads and galvanised iron roofs into the marine environments during rain events.

Analytical data for the water quality from Sites 1, 4 and 6 can be referred to in Appendix A.

Although temperature is not specifically recorded as an indicator of water quality in the Barker Inlet Central system, AGL is required to monitor cooling water temperature rise as part of their SA EPA license agreement. Coffey Environments has been advised that the new development will not involve marine cooling water discharges associated with its operation, so no changes are expected to the discharge water quality or temperature.

3.4.4 Potential Impacts

The risk of potential impacts from the project to waterways are low, however impact could be caused by:

- Spills of petroleum products from road tankers transporting LNG.
- Miscellaneous chemical spillage such as herbicides or pesticides.
- Localised channelling of stormwater run-off altering the marine environment.

3.5 Stormwater

3.5.1 General

According to the Australian Government Bureau of Meteorology, the average annual rainfall in the vicinity of Torrens Island is approximately 450mm/yr with the majority of rain being received in the late autumn and winter months (May to August). The fate and quality of stormwater from the TIPS site is currently unknown. Stormwater run-off is currently not re-used on site and therefore discharges (approximately 135 Mega litres per year) into the waterways of the Central Barker Inlet Segment.

3.5.2 Current Uses and Environmental Values

Coffey Environments has been advised that stormwater run-off is currently not re-used.

As stormwater most likely enters the Central Barker Inlet Segment the relevant protected environmental values for these waters, which are estuarine and marine, would be the SA EPP (2003) Water Quality Criteria for Maintenance of aquatic ecosystems – marine.

3.5.3 Water Quality

The quality of stormwater from the existing TIPS site was not established as part of this investigation.

3.5.4 Potential Impacts

Potential impacts to waterways could be caused if any impacted stormwater run-off from the proposed development is directed through the current stormwater outlets leading into the marine environment.

4 GROUNDWATER

4.1 General

Details of the regional groundwater were obtained from the Department of Water, Land and Biodiversity Conservation (DWLBC, 2009) on-line borehole search for boreholes within a 1 kilometre radius of the site. Details are presented in tables and a well location plan included in Appendix B.

A total of 129 wells were reported within 1 kilometre of the north western boundary of the current TIPS site of which 112 were classified as monitoring wells (ranging in depth to static water level (SWL) between 0.8 and 15.24 mbgs). 16 were classified as engineering wells (ranging in depth to SWL between 3.35 and 45.72 mbgs) and one as a water well (SWL 17.8 mbgs) which is located on the site.

Details of local groundwater conditions were obtained from the “Torrens Island Power Station Site Contamination Test Report” (Burns and Roe Worley (BRW, 2000) whose investigation targeted potential sites of contamination. The investigation involved installation of seven monitoring wells distributed predominantly on the southern edge of the site, with one located near the northern central site boundary and one centrally towards the east of the site.

On-site monitoring wells recorded SWL between 1.5 and 2.5 mbgs (BRW, 2000).

4.2 Aquifer Descriptions

Table 4.1 provides a summary of the inferred shallow aquifer descriptions based on an understanding of similar marine estuarine environments and previous experience undertaking investigations in the vicinity.

Table 4.1 Inferred Shallow Aquifer Descriptions

Water Bearing Unit	Approx. Extent (m AHD)	Description
Perched shallow groundwater– St. Kilda Formation	0 to -7	Possible unconfined, discontinuous water table within fill material or semi-confined natural, regionally extensive aquifer, occurring within grey/brown silty/sandy clays to clayey sands with shell grit and organic fibres. This unit may become more clayey with depth. Possibly hydraulically isolated from underlying Glanville Formation by Bakara Calcrete.
Intermediate Natural – Glanville Formation	-7 to -10	Semi-confined/confined natural, regionally extensive aquifer typically comprising abundant shelly fragments within beige sandy clay to clayey sand. This intermediate aquifer is likely to be confined to semi-connected with overlying St. Kilda Formation aquifer depending on thickness/presence of the Bakara Calcrete and clay content of sediments between the two units.
Hindmarsh Clay	-10 to -18	Confined natural, probably regionally extensive aquifer system within the Hindmarsh Clay. Deeper water bearing zones within the Hindmarsh Clay are likely to be present within sandy/gravel lenses.

4.3 Groundwater Uses

The on-site water well identified in the DWLBC search (unit number 6628-20472) is listed for industrial use with total dissolved solids (TDS) recorded as 1,681 mg/L and is located near the south eastern boundary of the current TIPS site. Current use by TIPS is for the production of demineralised water for the feedwater for the boiler to produce steam. One other exploration well on Torrens Island (unit number 6628-3360) located approximately 400m to the north-west of the site boundary reported a TDS concentration of 1,226 mg/L in 1962.

The seven wells monitored during the April 2000 investigation (BRW, 2000) reported TDS concentrations between 250 and 2,100 mg/L.

Based on the SA EPA “Guidelines for the Assessment and Remediation of Groundwater Contamination” (dated February 2009) these TDS concentrations indicate that the potential beneficial use of groundwater beneath the site is:

- Aquatic ecosystems: these include surface water (including marine) ecosystems and groundwater ecosystems.
- Potable use: intended for human consumption (drinking and domestic use).
- Recreation and aesthetics: including physical contact with the water.
- Industrial Water Use: including any industrial process, such as bottled water or beverages and includes activities such as cooling, heating, washing and evaporation

As the site is within the reticulated water supply for the Adelaide metropolitan area and the region is industrial, the beneficial uses are determined to be maintenance of aquatic ecosystems and industrial water use with the protected environmental values for groundwater being the SA EPP (2003) ‘Aquatic Ecosystem – fresh’ water quality criteria as well as ‘Recreation and Aesthetics – primary contact, secondary contact and aesthetics’ , ‘Agriculture/Aquaculture – aquaculture’ and ‘Industrial’ water quality criteria.

4.4 Water Quality

Water quality information has been based on data from analysis of groundwater samples taken from on-site monitoring wells during the April 2000 groundwater investigation (BRW, 2000) as little water chemistry information is available for other regional bores. The BRW investigation compared groundwater to ANZECC guidelines for the protection of freshwater aquatic ecosystems (ANZECC, 1992). Where no ANZECC guidelines were available, former Dutch ‘B’ levels were used. The groundwater investigation showed concentrations below the ANZECC guidelines for protection of aquatic ecosystems and former Dutch B criteria, except one well located in the eastern central portion of the site, where zinc concentrations were slightly above the former Dutch ‘B’ criteria.

A comparison with the current guidelines (SA EPP (2003) ‘Aquatic Ecosystem – fresh’ water quality criteria) of these results indicates that phosphorous, ammonia and turbidity may exceed the criteria, however the original laboratory analysis was not assessed against this current criteria and a direct comparison cannot be made. Further investigations would be required to assess whether there are exceedences and the source. Future comparisons should be analysed and compared to this criteria.

4.5 Groundwater Flow

Direction of groundwater flow within the shallow aquifer has not been determined, however the groundwater flow beneath the site is expected to be influenced by the tides and by the water pumping and discharge activities conducted by the TIPS (BRW,2000). Recharge of the groundwater is expected to occur by direct rainfall infiltration over the site area, periodic tidal inundation, from runoff and underflow from up-catchment and upward leakage from underlying aquifer systems. A major portion of the incident rainfall and its runoff from the site area would be expected to have drained to tidal channels and waterways.

4.6 Potential Impacts

Potential impacts to groundwater could be caused by:

- Accidental spills of petroleum products from road tankers carrying LNG; and.
- Infiltration of groundwater through any contaminated soil.

5 RECOMMENDATIONS

On the basis of the findings of this study, in order to control, minimise or where appropriate, mitigate impacts on surface water and groundwater, the following recommendations are made:

- Investigation of passive acid sulphate soils should be undertaken and remedial options undertaken prior to any construction activities.
- Any areas where spills may potentially occur should be fully bunded and isolated from all external water supplies.
- Monitoring of stormwater and cooling water discharges should be undertaken at least initially to establish the impact of these discharges on the marine environment.
- Baseline monitoring of surface water.
- Installation and monitoring of groundwater monitoring wells in the vicinity of the new development.

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Figures

Surface Water and Groundwater Assessment
Torrens Island Power Station Proposed Expansion
Torrens Island

Appendix A
SA EPA Monitoring Sites Data – Port Waterways

Surface Water and Groundwater Assessment
Torrens Island Power Station Proposed Expansion
Torrens Island

Port River site 1 *From 28/09/1995 and 28/02/2008*

SAMPLE DATE	Total N (mg/L)	ammonia (as N) (mg/L)	cadmium (total) (mg/L)	chlorophyll a (Ug/L)	copper (total) (mg/L)	dissolved oxygen (mg/L)	entercocci (per 100 mL)	lead (total) (mg/L)	mercury (total) (mg/L)	nickel (total) (mg/L)	oxidised N (as N) (mg/L)	Phosphorus (sol) (mg/L)	phosphorus (total as P) (mg/L)	TKN (as N) (mg/L)	turbidity (NTU)	zinc (total) (mg/L)
28-Feb-08	0.659	0.24	<.0005	15.9	0.0038			0.0006		0.0025	0.139	<.005	0.03	0.52	3.2	0.012
21-Nov-07	0.986	0.295	<.0005	12	0.006			0.0008		0.0037	0.236	<.005	0.045	0.75	4.7	0.018
23-Aug-07	1.138	0.466	<.0005	5.66	0.0031			0.0006		0.0013	0.378	0.008	0.026	0.76	1.1	0.023
13-Jun-07	1.008	0.54	<.0005	1.74	0.0032		11	0.0005	<.0003	0.0014	0.258	0.019	0.045	0.75	1.6	0.016
10-May-07	1.124	0.618	<.0005	4.49	0.0026		4	0.0008	<.0003	0.0015	0.164	0.028	0.062	0.96	2	0.014
11-Apr-07	0.627	0.174	<.0005	14.3	0.0015	9.01	0	0.0008	<.0003	0.0008	0.097	0.006	0.021	0.53	1.7	0.01
14-Mar-07	0.804	0.236	<.0005	32.5	0.0024		1	0.0011	<.0003	0.0011	0.094	<.005	0.023	0.71	8.5	0.012
13-Feb-07	1.829	1.365	<.0005	4.53	0.0036		4	0.0008	<.0003	0.0009	0.109	0.006	0.033	1.72	2.8	0.015
10-Jan-07	0.916	0.461	<.0005	15.8	0.0012	8.17	4	<.0005	<.0003	0.0016	0.176	0.007	0.026	0.74	1.8	0.01
12-Dec-06	0.341	0.165	<.0005	13	0.0029		0	0.0007	<.0003	0.0016	0.141	0.006	0.038	0.2	3.1	0.027
17-Nov-06	0.465	0.135	<.0005	7.14	0.0024	7.11	19	0.001	<.0003	0.0009	0.135	0.007	0.046	0.33	2.4	0.02
12-Oct-06	0.758	0.495	<.0005	5.23	0.0038	7.4	2	0.0008	<.0003	0.0019	0.228	0.005	0.03	0.53	1.9	0.014
07-Sep-06	0.802	0.37	<.0005	6.66	0.0046	7.7	15	0.001	<.0003	0.0013	0.232	0.005	0.052	0.57	1.5	0.018
07-Aug-06	0.911	0.392	<.0005	1.65	0.0025	7	1	0.0006	<.0003	0.0014	0.281	0.01	0.053	0.63	1.4	0.012
20-Jul-06	0.912	0.454	<.0005	1.38	0.0071	7.5	3	0.0013	<.0003	0.0017	0.292	0.011	0.034	0.62	1.4	0.02
08-Jun-06	1.309	0.899	<.005	2.95	<.01	5.9	1	<.005	<.0003	<.005	0.299	0.009	0.033	1.01	0.87	0.092
02-May-06	0.505	0.15	<.005	13.4	<.01	6.3	45	<.005	<.0003	<.005	0.145	<.005	0.033	0.36	2.3	<.03
03-Apr-06	0.582	0.1	<.005	28.7	<.01	7.3	7	<.005	<.0003	<.005	0.112	<.005	0.046	0.47	2.7	<.03
07-Mar-06	0.783	0.287	<.005	21.8	<.01	6.4	8	<.005	0.0004	<.005	0.143	0.006	0.035	0.64	2.7	<.03
13-Feb-06	0.813	0.624	<.005	4.62	<.01	6.7	8	<.005	<.0003	<.005	0.113	<.005	0.028	0.7	4.8	<.03
17-Jan-06	0.477		<.005	8.58	<.01	5.3	6	<.005	<.0003	<.005	0.107	<.005	0.111	0.37	3.3	<.03
08-Dec-05	0.727	0.28	<.005	16.2	<.01	6.8	2	<.005	<.0003	0.008	0.127	<.005	0.037	0.6	4.9	<.03
17-Nov-05	1.24	0.277	<.005	23.8	<.01	9.2	2	<.005	<.0003	0.006	0.12	<.005	0.049	1.12	3.5	<.03
06-Oct-05	0.619	0.272	<.005	12.24	0.012	7.3	2	<.005	<.0003	0.0107	0.169	<.005	0.046	0.45	2.46	0.0349
01-Sep-05	1.651	0.341	<.005	17	0.0146	8.3	31	<.005	<.0003	<.005	0.321	<.005	0.047	1.33	2.25	0.0395
11-Aug-05	1.175	0.459	<.005	5	0.0211	7.1	17	<.005	<.0003	<.005	0.375	0.012	0.05	0.8	1.99	0.0425
13-Jul-05	1.175	0.739	<.005	4.3	0.0363	6.9	13	<.005	<.0003	<.005	0.328	0.022	0.059		1.98	0.0348
09-Jun-05	0.804	0.56	<.005	5.53	0.0204	8.1	3	<.005	<.0003	<.005	0.194	0.014	0.044	0.61	1.69	0.0362
05-May-05	1.341	0.869	<.005	3.9	0.0228	4.2	3	<.005	<.0003	<.005	0.241	0.021	0.109	1.1	1.99	0.0454
06-Apr-05	0.559	0.258	<.005	12.31	0.0157	6.3	0	<.005	<.0003	<.005	0.149	0.008	0.056	0.41	1.69	0.0482
18-Mar-05	1.051	0.473	<.005	7.3	<.01	5.7	11	<.005	<.0003	<.005	0.131	0.016	0.066	0.92	1.47	<.03
15-Feb-05	0.763	0.322	<.002	9.77	<.01		5	<.005	<.0003	<.02	0.153	0.006	0.043	0.61	1.62	<.03
18-Jan-05	0.675	0.403	0.0059	15.41	0.0276		0	<.005	<.0003		0.135		0.064	0.54	2.175	<.03
21-Dec-04	0.996	0.335	<.005	6.03	0.0211		1	<.005	<.0003		0.336		0.057	0.66	9.75	<.03
23-Nov-04	0.705	0.538	<.005	12.59	<.01		0	<.005	<.0003		0.205		0.06	0.5	4.24	<.03
21-Oct-04	1.276	0.559	<.005	14	<.01		1	<.005	<.0003		0.356		0.053	0.92	1.93	<.03
15-Sep-04	1.455	0.637	<.005	2.8	<.01		16	<.005	0.0006		0.505		0.09	0.95	1.14	<.03
18-Aug-04	1.362	0.597	<.005	1.9	0.0112		5	<.005	0.0004		0.492		0.096	0.87	1.27	0.1368
19-Jul-04	1.658	0.758	<.005	4.31	<.01		8	<.005	0.0005		0.598		0.117	1.06	1.11	<.03
17-Jun-04	1.638	0.823	<.005	2.6	<.01		36	<.005	<.0003		0.548		0.142	1.09	1.12	<.03
19-May-04	1.325	0.665	<.005	4.5	0.0223		80	<.005	<.0003		0.485		0.169	0.84	1.07	<.03
19-Apr-04	1.63	0.758	<.005	15.51	<.01		8	<.005	<.0003		0.36		0.195	1.27	2.41	<.03
18-Mar-04	1.478	1.09	<.005	22.07	<.01		12	<.005	<.0003		0.338		0.12	1.14	1.78	<.03
05-Feb-04	0.926	0.594	<.005	11.15	<.01		7	<.005	<.0003		0.206		0.06	0.72	0.652	<.03
08-Jan-04	1.138	0.328	0.0067	14.72	<.01		11	<.005	<.0003		0.288		0.138	0.85	1.83	<.03
04-Dec-03	2.013	0.991	<.005	37.1	<.01		24	<.005	0.0055		0.513		0.086	1.5	1.83	<.03
03-Nov-03	6.64	1.87	<.005	330.47	<.01		1	<.005	<.0003		0.19		0.555	6.45	17.2	<.03
30-Oct-03	1.756	0.179	<.005	66.46	<.01		19	<.005	0.0005		0.496		0.139	1.26	1.22	<.03
11-Sep-03	1.611	0.716	<.005	5.96	<.011		1	<.005	<.0003		0.581		0.099	1.03	0.646	<.033
14-Aug-03	2.103	1.127	<.005	2.84	<.01		25	<.005	0.0004		0.643		0.107	1.46	1.44	<.03
17-Jul-03	1.574	0.868	<.005	8.31	<.01		1	<.005	<.0003		0.534		0.134	1.04	0.766	<.03
19-Jun-03	1.934	1.14	<.005	0.96	<.01		5	<.005	<.0003		0.494		0.132	1.44	0.722	<.03
15-May-03	1.864	0.975	<.005	4.26	<.01		2	<.005	<.0003		0.494		0.123	1.37	1.57	<.03
30-Apr-03	1.331	0.493	<.005	3.2	<.01		48	<.005	<.0003		0.271		0.075	1.06	1.25	<.03
22-Mar-03	1.317	0.415	<.005	1.59	<.01		12	<.005	<.0003		0.247		0.081	1.07	1.91	<.03
25-Feb-03	1.849	0.637	<.005	7.73	<.01		16	<.005	<.0003		0.289		0.118	1.56	2.57	<.03
10-Jan-03	1.265	0.481	<.005	9.9	<.01		10	<.005	<.0003		0.255		0.07	1.01	1.48	<.03
19-Dec-02	1.54	0.244	<.005	49.8	<.01		2	<.005	<.0003		0.54		0.13	1	3.48	<.03
14-Nov-02	2.103	0.68	<.005	35	<.01		2	<.005	<.0003		0.603		0.117	1.5	7.38	<.03
28-Oct-02	2.066	0.744	<.005	11.12	<.01		0	<.005	0.0007		0.626		0.154	1.44	1.97	<.03
27-Sep-02	1.3695	0.336	<.005	14.4	<.01		5	<.005	<.0003		0.5795		0.092	0.79	2.96	<.03
15-Aug-02	2.21	1.12	<.005	5.16	<.01		10	<.005	<.0003		0.71		0.109	1.5	1	<.03
26-Jul-02	1.8957	0.945	<.005	1.02	0.0161		26	<.005	<.0003		0.6757		0.09	1.22	2.14	0.0487
29-Jun-02	2.296	1.07	<.005	2.35	<.01		39	<.005	<.0003		0.836		0.194	1.46	0.961	<.03
11-Apr-02	1.7904	0.342	<.005	49.46	<.01		4	<.005	0.0004		0.3004		0.142	1.49	4.15	<.03
14-Mar-02	1.0619	0.246	<.005	26.26	<.01		6	<.005	<.0003		0.2919		0.148	0.77	2.13	<.03
21-Feb-02	1.452	0.959	<.005	6.52	<.01		1	<.005	0.0003		0.342		0.114	1.11	1.93	<.03
31-Jan-02	1.4802	0.44	<.005	12.94	0.0268		8	<.005	<.0003		0.2702		0.092	1.21	5.04	<.03
06-Dec-01	1.4775	0.741	<.005	12.8	<.01		4	<.005	<.0003		0.3275		0.105	1.15	3.37	<.03
08-Nov-01	1.2247	0.717	<.005	2.65	<.01		0	<.005	0.0007		0.3047		0.081	0.92	2.87	<.03
25-Oct-01	1.4738	0.674	<.004	11.79	<.01		5	<.05	0.0003		0.3738		0.11	1.1	1.73	<.1
30-Aug-01	3.284	2.05	<.0004	5.77	0.009		4	<.005	0.0066		0.734		0.0965	2.55	2.81	<.01
02-Aug-01	2.453	1.38	<.0004	3.27	0.006		9	<.005	<.0003		0.853		0.11	1.6	0.724	<.01
24-May-01	2.012	1.1	<.0004	8.3	<.001		10	<.005	0.0004		0.512		0.14	1.5	1.5	<.01
29-Mar-01	1.5838	0.95	<.0004	4.92	0.003		12	<.005	0.0057		0.2838		0.11	1.3	2.31	<.01
22-Feb-01	2.1906	0.576	<.0004	129.54	0.0907		2	0.006	<.0003		0.1906		0.29	2	4.67	<.01
30-Jan-01	1.5763	0.622	<.0004	50	0.002		1	<.005	<.0003		0.2763		0.15	1.3	1.77	<.01
07-Dec-00	1.422	0.395	<.0004	18.2	0.006		0	<.005	<.0003		0.482		0.084	0.94	3.9	<.01
26-Oct-00	1.2587	0.517	<.0004	5.98	<.001		4	<.005	0.0004		0.4187		0.06	0.84	2.72	<.01
10-Aug-00	2.2922	1.02	<.0004	4.67	0.002		820	<.005	<.0003		0.7922		0.16	1.5	1.38	<.01
04-Jul-00	2.198	1.16	<.0004	1.18	<.002		13	0.006	<.0003		0.698		0.15	1.5	1.65	0.038
08-Jun-00	1.715	0.874	<.0004	1.52	0.001		14	<.005	<.0003		0.615		0.1	1.1	1.66	<.01
18-May-00	1.565	0.75	<.0004	0.76	0.002		5	<.005	<.0003		0.565		0.085	1	1.42	<.01
13-Apr-00	1.468	0.665	<.0004	6.19	0.002		12	<.005	0.0005		0.518		0.12	0.95	39.3	<.01
20-Mar-00	1.439	0.515	<.0004	10.82	0.001		4	<.005	<.0003		0.489		0.099	0.95	2.6	0.0107
24-Feb-00	1.294	0.84	0.0004	3.86	<.001		7	0.008	0		0.394		0.074	0.9	3.16	0.0129
20-Jan-00	1.329	0.44	0.0005	47.71	0.002		2	<.005	<.0003		0.419		0.11	0.91	3.73	0.0477
23-Dec-99	1.373	0.36	<.0004	73.57	0.002		6	<.005	<.0003		0.493		0.06	0.88	2.3	0.0193
25-Nov-99	1.415	0.53	<.0004	12.58	0.003		1	<.005	<.0003		0.555		0.054	0.86	1.56	0.0388
14-Oct-99	1.898	0.73	<.0004	21.78	0.004		4	<.005	<.0003		0.798		0.1	1.1	1.17	0.0253
08-Sep-99	2.635	1.74	<.0004	3.95	0.006		2	<.005	<.0003		0.805		0.06	1.83	3.56	0.0092
05-Aug-99	2.219	1.36	<.0004	2.87	0.0064		3	<.005	<.0003		0.819		0.61	1.4	4.55	0.0099
10-Jun-99	2.1	1.4	<.0005	1.74	0.01		13	<.005	<.0005		0.5		0.086	1.6	4.8	0.0148
13-May-99	2.305	1.48	<.0004	8.8	0.002		90	<.005	<.0003		0.605		0.15	1.7	2.6	0.027
28-Apr-99	2.9	2.24	<.0004	6.19	0.0032		12	<.005	<.0003		0.5		0.164	2.4	1.64	0.118

Port River site 1 *From 28/09/1995 and 28/02/2008*

SAMPLE DATE	Total N (mg/L)	ammonia (as N) (mg/L)	cadmium (total) (mg/L)	chlorophyll a (Ug/L)	copper (total) (mg/L)	dissolved oxygen (mg/L)	entercocci (per 100 mL)	lead (total) (mg/L)	mercury (total) (mg/L)	nickel (total) (mg/L)	oxidised N (as N) (mg/L)	Phosphorus (sol) (mg/L)	phosphorus (total as P) (mg/L)	TKN (as N) (mg/L)	turbidity (NTU)	zinc (total) (mg/L)
11-Mar-99	2.591	1.48	<.0004		0.0032			<.005	<.001		0.491		0.14	2.1	2.92	0.125
04-Feb-99	1.445	0.89	<.0002	43.76	0.003		7	<.005	<.0001		0.465		0.082	0.98	3	0.105
07-Jan-99	2.124	1.03	<.0002	37.96	0.003		18	0.006	<.0001		0.624		0.083	1.5	2.9	0.054
12-Nov-98	1.997	1.05	<.0002	10.56	0.005		720	<.005	<.0001		0.697		0.099	1.3	3.26	0.024
03-Sep-98	1.965	0.89	0.0002	7.64	0.004		0	<.005	<.0001		0.865		0.076	1.1	1.5	0.041
12-Aug-98	1.955	1	0.0004	12.28	0.007		6	0.008	<.0001		0.955		0.13	1	78.1	<.01
02-Jul-98	1.558	0.74	<.0002	2.9	0.0053		10	<.005	0.0001		0.678		0.065	0.88	2.1	0.1009
28-May-98	1.558	0.87	<.0002	2.89	0.005		5	<.005	<.0001		0.749		0.154		1.3	0.196
30-Apr-98	1.78	0.94	0.0007	9	0.003		86	<.005	<.0001		0.5		0.32	1.28	2.3	0.08
05-Mar-98	1.114	0.71	<.0002	9.3	0.0081		6	<.001	<.0001		0.424		0.112	0.69	2.5	0.114
12-Feb-98	1.4	0.4	0.0006	58	0.003		2	<.005	<.0001		0.3		0.108	1.1	2.5	0.092
22-Jan-98	1.443	0.48	0.0004	19	0.008		5	<.005	<.0001		0.263		0.07	1.18	3.1	0.051
19-Dec-97	1.242	0.55	0.0012	13	0.005		16	<.005	<.0001		0.342		0.08	0.9	4.8	0.138
26-Nov-97	0.956	0.16	0.0005		0.009			<.005	0.0001		0.256		0.08	0.7	13	0.095
20-Nov-97				7.1			5									
16-Oct-97	1.495	0.4	0.001	16	0.006		5	<.005	<.0001		0.395		0.09	1.1	4	0.041
18-Sep-97	2.188	1.1	<.0002	2.7	0.004		5	0.016	<.0001		0.688		0.115	1.5	1.6	0.094
21-Aug-97	1.886	0.76	<.0002	16	0.006		2	0.003	<.0001		0.836		0.12	1.05	6.6	0.073
24-Jul-97	3.77	1.7	0.0003	7.3	0.007		1	0.006	0.0001		1.22		0.12	2.55	11	0.025
24-Jun-97	3.77	0.21	<.001	<1	0.012			<.005	<.0005				0.021	0.375	0.4	0.029
27-May-97	3.77	0.97	<.001	<1	<.01			<.005	<.0005				0.074	1.1	0.7	0.024
29-Apr-97	3.77	0.74	<.001	1	0.01			<.005	<.0005				0.076	1.2	1.4	0.016
18-Mar-97	3.77	0.48	<.001	8	<.01			<.005	<.0005				0.051	0.86	1.8	0.017
25-Feb-97	3.77	0.8	<.001	6	<.01			<.005	<.0005				0.065	1.1	1.7	<.01
27-Jan-97	3.77	0.59	<.001	2	0.019			<.005	<.0005				0.042	0.94	1.3	0.017
19-Dec-96	3.77	0.455	<.001	7	<.01			<.005	<.0005				0.12	1.2	9.4	0.035
26-Nov-96	3.77	0.64	<.001	3	<.01			<.005	<.0005				0.064	1	1.2	<.01
31-Oct-96	3.77	0.465	<.001	0.005	0.017			<.005	<.0005				0.074	0.83	1.1	0.038
27-Sep-96	3.77	0.52	<.001	1	0.034			<.005	<.0005				0.071	1	3.2	0.013
30-Aug-96	3.77	0.76	<.001	<1	<.005			<.005	<.0005				0.065	1.1	2.1	0.017
31-Jul-96	3.77	0.81	<.001	6	0.012			<.005	<.0005				0.09	1.2	1.7	0.024
21-Jun-96	3.77	0.1	0.001	17	0.037		12	0.007	0.0001				0.01	0.8	2.7	0.056
16-May-96	3.77	1.1	0.001	5	0.032		5	0.004	0.0001				0.1	0.5	1	0.089
08-Mar-96	3.77	0.5	0.001	9.9	0.022		4	0.001	0.0001				0.32	0.5	10	0.053
29-Jan-96	3.77	0.5	0.001	27	0.019		3	0.001	0.0001				0.07	1.4	5	0.041
08-Jan-96	3.77	0.1	0.0039	39	0.017		5	0.0005	0.0001				0.37	0.1	16	0.11
04-Dec-95	3.77	0.1	0.0005	3.8	0.0046		1	0.0005	0.0001				0.28	0.1	0.5	0.061
30-Oct-95	3.77	0.9	0.0005	16	0.0005		1	0.006	0.0001				0.38	2.6	0.5	0.19
28-Sep-95	3.77	0.1	0.0005	12	0.014		1	0.005	0.0001				0.141	1.5	0.5	0.008

Port River site 4 *From 28/09/1995 and 20/06/2008*

SAMPLE_DATE	Total N (mg/L)	ammonia (as N) (mg/L)	cadmium (total) (mg/L)	chlorophyll a (Ug/L)	copper (total) (mg/L)	dissolved oxygen (mg/L)	entercocci (per 100 mL)	lead (total) (mg/L)	mercury (total) (mg/L)	nickel (total) (mg/L)	oxidised N (as N) (mg/L)	Phosphorus (sol) (mg/L)	phosphorus (total as P) (mg/L)	TKN (as N) (mg/L)	turbidity (NTU)	zinc (total) (mg/L)
20-Jun-08	0.88	0.484	<.0005	1.78	0.002			0.0006		0.0015	0.29	0.017	0.037	0.59	0.87	0.008
28-Feb-08	0.765	0.404	<.0005	2.16	0.0031			0.0007		0.0021	0.165	0.008	0.037	0.6	0.78	0.011
21-Nov-07	1.074	0.361	<.0005	3.32	0.005			0.0006		0.0036	0.334	0.016	0.044	0.74	3.1	0.02
23-Aug-07	1.312	0.48	<.0005	1.24	0.003			0.0021		0.0018	0.512	0.01	0.026	0.8	1.3	0.016
13-Jun-07	1.026	0.574	<.0005	5.27	0.0037		4	0.0006	<.0003	0.0016	0.206	0.016	0.048	0.82	1.7	0.015
10-May-07	1.124	0.48	<.0005	1.83	0.0022		3	0.0009	<.0003	0.0021	0.264	0.027	0.07	0.86	2.4	0.012
11-Apr-07	0.606	0.166	<.0005	7.56	0.0014	5.12	3	0.0008	<.0003	0.001	0.126	0.009	0.031	0.48	1.9	0.013
14-Mar-07	1.081	0.318	<.0005	8.09	0.002		4	0.0006	<.0003	0.001	0.151	0.006	0.032	0.93	3	0.01
13-Feb-07	1.246	0.615	<.0005	1.63	0.0021		0	0.0007	<.0003	0.0012	0.176	0.01	0.042	1.07	2.7	0.016
10-Jan-07	0.638	0.251	<.0005	10.3	0.0021	7.44	8	0.0007	<.0003	0.0014	0.198	<.005	0.029	0.44	3.1	0.016
12-Dec-06	0.538	0.262	<.0005	1.61	0.0025		0	0.0005	<.0003	0.0012	0.218	0.012	0.031	0.32	2	0.022
17-Nov-06	0.549	0.201	<.0005	6.65	0.0024	7.37	0	0.0006	<.0003	0.001	0.129	0.007	0.032	0.42	1.2	0.021
12-Oct-06	0.898	0.454	<.0005	3.01	0.0052	6.8	3	0.0005	<.0003	0.002	0.278	0.006	0.015	0.62	2.5	0.016
07-Sep-06	0.915	0.481	<.0005	1.82	0.0036	6.8	3	0.0009	<.0003	0.0014	0.265	0.008	0.056	0.65	2.3	0.019
07-Aug-06	1.035	0.64	<.0005	1.97	0.0022	7.3	0	0.0005	<.0003	0.0012	0.245	0.009	0.051	0.79	1.9	0.01
20-Jul-06	1.106	0.48	<.0005	1.16	0.0045	7.6	1	0.0007	<.0003	0.0018	0.326	<.005	0.028	0.78	1.4	0.024
08-Jun-06	1.479	0.922	<.005	3.08	<.01	6.6	5	<.005	<.0003	<.005	0.449	<.005	0.029	1.03	3.2	0.152
02-May-06	0.566	0.242	<.005	2.38	<.01	4.9	3	<.005	<.0003	<.005	0.186	0.01	0.041	0.38	3.2	<.03
03-Apr-06	0.54	0.219	<.005	6.35	<.01	5.4	4	<.005	<.0003	<.005	0.12	0.006	0.038	0.42	4.3	<.03
07-Mar-06	0.803	0.415	<.005	9.73	<.01	4.7	2	<.005	0.0004	<.005	0.193	0.008	0.034	0.61	2.3	<.03
13-Feb-06	0.698	0.343	<.005	6.78	<.01	5.3	14	<.005	<.0003	<.005	0.138	0.006	0.046	0.56	6.4	<.03
17-Jan-06	0.942	0.604	<.005	4.07	<.01	4.4	3	<.005	0.0004	<.005	0.142	0.006	0.041	0.8	4.6	<.03
08-Dec-05	0.889	0.86	<.005	10.6	<.01	6.5	2	<.005	<.0003	<.005	0.149	<.005	0.031	0.74	3.8	<.03
17-Nov-05	1.078	0.296	<.005	16.7	<.01	8.1	5	<.005	<.0003	0.008	0.128	<.005	0.061	0.95	8.9	<.03
06-Oct-05	0.781	0.438	<.005	5.58	0.011	6.4	4	<.005	<.0003	0.016	0.181	0.014	0.054	0.6	4.15	0.0351
01-Sep-05	1.607	0.371	<.005	11.9	0.023	7.2	23	<.005	<.0003	<.005	0.297	0.006	0.041	1.31	2.09	0.0411
11-Aug-05	1.158	0.422	<.005	1.8	0.0187	7	14	<.005	<.0003	<.005	0.388	0.014	0.048	0.77	2.05	0.0433
13-Jul-05	1.158	0.696	<.005	1.7	0.0448	6.6	21	<.005	<.0003	<.005	0.351	0.023	0.037		1.22	0.0374
09-Jun-05	0.778	0.464	<.005	2.26	0.021	6.9	7	<.005	<.0003	<.005	0.228	0.018	0.035	0.55	2.07	0.0395
05-May-05	0.988	0.592	<.005	2.5	0.0356	4	6	<.005	<.0003	<.005	0.228	0.022	0.06	0.76	2.31	0.0654
06-Apr-05	0.629	0.447	<.005	4.85	0.0173	5	2	<.005	<.0003	<.005	0.169	0.014	0.05	0.46	1.87	0.0523
18-Mar-05	0.85	0.548	<.005	2.17	<.01	5	10	<.005	<.0003	<.005	0.16	0.018	0.044	0.69	1.45	<.03
15-Feb-05	0.729	0.272	<.002	4.43	<.01		7	<.005	<.0003	<.02	0.149	0.014	0.05	0.58	1.85	<.03
18-Jan-05	0.862	0.364	<.002	1.87	<.01		1	<.005	<.0003		0.232		0.058	0.63	0.991	<.03
21-Dec-04	1.147	0.374	<.005	3.55	0.0204		1	<.005	<.0003		0.357		0.04	0.79	1.17	<.03
23-Nov-04	0.643	0.122	<.005	7.87	<.01		3	<.005	<.0003		0.203		0.037	0.44	1.33	<.03
21-Oct-04	1.215	0.596	<.005	4.1	<.01		7	<.005	<.0003		0.365		0.058	0.85	1.82	<.03
15-Sep-04	1.27	0.405	<.005	1.2	<.01		45	<.005	<.0003		0.48		0.089	0.79	1.43	<.03
18-Aug-04	1.273	0.465	<.005	1.2	<.01		27	<.005	<.0003		0.503		0.096	0.77	1.36	<.03
19-Jul-04	1.421	0.498	<.005	0.87	<.01		20	<.005	<.0003		0.711		0.103	0.71	1.04	<.03
17-Jun-04	1.479	0.721	<.005	1.8	<.01		44	<.005	<.0003		0.549		0.13	0.93	1.25	<.03
19-May-04	1.168	0.528	<.005	1.49	0.0253		50	<.005	<.0003		0.408		0.11	0.76	1.54	<.03
19-Apr-04	1.479	0.635	<.005	4.21	<.01		5	<.005	<.0003		0.329		0.119	1.15	1.73	<.03
18-Mar-04	1.098	0.814	<.005	3.76	<.01		20	<.005	<.0003		0.288		0.092	0.81	1.48	<.03
05-Feb-04	0.834	0.331	<.005	3.13	<.01		9	<.005	<.0003		0.164		0.058	0.67	0.65	<.03
08-Jan-04	0.744	0.303	0.0065	1.46	<.01		8	<.005	<.0003		0.214		0.096	0.53	1.33	<.03
04-Dec-03	1.298	0.388	<.005	12.57	<.01		24	<.005	<.0003		0.468		0.068	0.83	0.713	<.03
03-Nov-03	0.891	0.223	<.005	1.19	<.01		2	<.005	<.0003		0.341		0.066	0.55	1.28	<.03
30-Oct-03	0.875	0.205	<.005	2.19	<.01		6	<.005	<.0003		0.335		0.067	0.54	0.8765	<.03
11-Sep-03	1.137	0.473	<.005	1.84	<.011		5	<.005	<.0003		0.517		0.071	0.62	0.889	<.033
14-Aug-03	1.762	0.704	<.005	0.92	<.01		11	<.005	0.0003		0.742		0.08	1.02	1.17	<.03
17-Jul-03	1.172	0.581	<.005	0.96	<.01		2	<.005	<.0003		0.442		0.09	0.73	0.609	<.03
19-Jun-03	1.892	0.981	<.005	0.72	<.01		5	<.005	<.0003		0.572		0.108	1.32	1.28	<.03
15-May-03	1.584	0.703	<.005	0.87	<.01		9	<.005	<.0003		0.516		0.077	1.068	1.51	<.03
30-Apr-03	1.548	0.6	<.005	2.13	<.01		6	<.005	<.0003		0.342		0.076	1.206	1.5	<.03
22-Mar-03	1.479	0.439	<.005	2.78	<.01		39	<.005	<.0003		0.289		0.099	1.19	2.26	<.03
25-Feb-03	1.589	0.57	<.005	9.94	<.01		7	<.005	<.0003		0.319		0.126	1.27	1.84	<.03
10-Jan-03	1.327	0.525	<.005	8.27	<.01		12	<.005	<.0003		0.307		0.07	1.02	1.94	<.03
19-Dec-02	1.277	0.38	<.005	3.48	<.01		8	<.005	<.0003		0.427		0.084	0.85	3.06	<.03
14-Nov-02	1.932	0.569	<.005	26	<.01		0	<.005	<.0003		0.592		0.087	1.34	2.25	<.03
28-Oct-02	1.781	0.595	<.005	4.64	<.01		3	<.005	0.0011		0.631		0.094	1.15	1.71	<.03
27-Sep-02	1.244	0.455	<.005	2.9	<.01		6	<.005	<.0003		0.424		0.053	0.82	2.33	<.03
15-Aug-02	2.1605	1.05	<.005	1.15	<.01		14	<.005	<.0003		0.7505		0.088	1.41	1.12	<.03
26-Jul-02	1.7902	0.829	<.005	0.91	0.0182		2	<.005	<.0003		0.6792		0.091	1.111	1.91	0.0497
29-Jun-02	1.5625	0.658	<.005	0.98	<.01		3	<.005	<.0003		0.6325		0.098	0.93	0.907	<.03
11-Apr-02	1.2687	0.581	<.005	3.04	<.01		2	<.005	<.0003		0.2887		0.072	0.98	1.13	<.03
14-Mar-02	0.8857	0.309	<.005	3.32	<.01		8	<.005	<.0003		0.2457		0.087	0.64	1.84	<.03
21-Feb-02	1.7453	1.07	<.005	8.17	<.01		8	<.005	0.0003		0.3753		0.066	1.37	2	<.03
31-Jan-02	1.2185	0.35	<.005	11.68	<.01		1	<.005	<.0003		0.2385		0.088	0.98	2.58	<.03
06-Dec-01	1.2529	0.606	<.005	6.01	<.01		11	<.005	0.0023		0.3429		0.082	0.91	1.96	<.03
08-Nov-01	1.0298	0.137	<.005	1.94	<.01		3	<.005	0.0005		0.3698		0.077	0.66	1.96	<.03
25-Oct-01	0.9989	0.327	<.004	2.13	<.01		6	<.05	0.0003		0.3389		0.065	0.66	1.7	<.1
30-Aug-01	2.0975	1.05	<.0004	6.13	0.0095		4	<.005	0.0005		0.7975		0.095	1.3	1.07	<.01
02-Aug-01	2.258	1.27	<.0004	1.63	0.006		4	<.005	<.0003		0.858		0.096	1.4	1.23	<.01
24-May-01	1.753	0.873	<.0004	2.61	0.004		11	<.005	<.0003		0.553		0.099	1.2	1.49	<.01
29-Mar-01	1.3758	0.669	<.0004	2.93	0.003		11	<.005	<.0003		0.2758		0.083	1.1	2.22	<.01
22-Feb-01	1.1359	0.202	<.0004	22.9	<.001		10	0.006	<.0003		0.1659		0.077	0.97	3.18	<.01
30-Jan-01	1.1819	0.378	<.0004	27	0.003		16	0.006	<.0003		0.2519		0.1	0.93	2.98	<.01
07-Dec-00	1.0123	0.272	<.0004	4.52	0.006		3	<.005	<.0003		0.4823		0.074	0.53	1.51	<.01
26-Oct-00	1.1014	0.328	<.0004	2.76	<.001		3	<.005	<.0003		0.4514		0.061	0.65	1.61	<.01
10-Aug-00	1.1417	0.75	<.0004	1.91	0.001		5	<.005	<.0003		0.0417		0.086	1.1	1.28	<.01

SAMPLE_DATE	Total N (mg/L)	ammonia (as N) (mg/L)	cadmium (total) (mg/L)	chlorophyll a (Ug/L)	copper (total) (mg/L)	dissolved oxygen (mg/L)	entercocci (per 100 mL)	lead (total) (mg/L)	mercury (total) (mg/L)	nickel (total) (mg/L)	oxidised N (as N) (mg/L)	Phosphorus (sol) (mg/L)	phosphorus (total as P) (mg/L)	TKN (as N) (mg/L)	turbidity (NTU)	zinc (total) (mg/L)
04-Jul-00	1.763	0.695	<.0004	0.77	<.002		6	0.006	<.0003		0.763		0.098	1	2.81	0.031
08-Jun-00	1.432	0.68	<.0004	0.68	<.001		7	<.005	<.0003		0.702		0.076	0.73	1.2	<.01
18-May-00	1.494	0.71	<.0004	1.04	0.003		5	0.005	<.0003		0.574		0.085	0.92	1.62	<.01
13-Apr-00	1.258	0.573	<.0004	1.11	0.003		8	<.005	<.0003		0.538		0.059	0.72	0.9	<.01
20-Mar-00	1.147	0.359	<.0004	2.68	0.002		18	<.005	<.0003		0.497		0.066	0.65	1.75	0.0147
24-Feb-00	1.512	0.78	<.0004	13.23	0.002		3	<.005	0		0.412		0.16	1.1	2.32	0.0204
20-Jan-00	1.115	0.32	<.0004	17.03	0.002		8	<.005	<.0003		0.435		0.068	0.68	4.13	0.0195
23-Dec-99	0.84	0.16	<.0004	29.1	0.003		11	<.005	<.0003		0.43		0.029	0.41	1.59	0.0669
25-Nov-99	1.202	0.375	<.0004	2.34	0.004		3	<.005	0.0003		0.572		0.05	0.63	4.35	0.0237
14-Oct-99	1.388	0.58	<.0004	1.88	0.004		36	<.005	<.0003		0.738		0.071	0.65	1.6	0.0197
08-Sep-99	2.365	1.29	<.0004	4.1	0.003		2	<.005	<.0003		0.865		0.06	1.5	1.45	0.0128
05-Aug-99	2.176	1.17	<.0004	1.83	0.0049		1	<.005	<.0003		0.976		0.063	1.2	2.09	0.0084
10-Jun-99	1.703	1.12	<.0005	0.64	0.0046		6	<.005	<.0005		0.503		0.084	1.2	2.2	0.1133
13-May-99	1.982	1.04	<.0004	5	0.004		22	<.005	<.0003		0.682		0.11	1.3	3.6	0.032
28-Apr-99	1.885	1	<.0004	1.31	0.0046		8	<.005	<.0003		0.785		0.078	1.1	2.21	0.105
11-Mar-99	3.642	2.6	<.0004		0.0871			<.005	<.001		0.642		0.082	3	2.04	0.096
04-Feb-99	1.218	0.66	<.0002	3.12	0.004		31	<.005	<.0001		0.488		0.059	0.73	3.2	0.12
07-Jan-99	2.51	1.76	<.0002	33	0.003		1	<.005	<.0001		0.61		0.07	1.9	3.1	0.048
12-Nov-98	1.62	0.92	<.0002	3.9	0.002		9	<.005	<.0001		0.52		0.056	1.1	2.73	0.029
03-Sep-98	1.704	0.69	<.0002	2.85	0.002		2	0.01	<.0001		0.944		0.056	0.76	1.03	0.014
12-Aug-98	1.858	0.87	0.0007	1.57	0.003		2	<.005	<.0001		0.948		0.049	0.91		0.043
02-Jul-98	1.506	0.57	<.0002	0.5	0.0029		3	<.005	<.0001		0.766		0.073	0.74	1.2	0.065
28-May-98	1.437	0.55	<.0002	0.77	0.002		12	<.005	<.0001		0.797		0.036	0.64	1.6	0.068
30-Apr-98	1.405	0.46	<.0002	1.69	0.002		9	<.005	<.0001		0.405		0.06	1	1.4	0.034
05-Mar-98	1.196	0.525	<.0002	1.8	0.0023		34	<.001	<.0001		0.456		0.079	0.74	1	0.1179
12-Feb-98	1.04	0.31	<.0002	9.1	0.002		12	<.005	<.0001		0.23		0.078	0.81	3.4	0.078
22-Jan-98	1.282	0.42	<.0002	17	0.002		15	<.005	<.0001		0.312		0.06	0.97	1.4	0.019
19-Dec-97	1.168	0.39	<.0002	3.3	0.003		11	<.005	<.0001		0.368		0.065	0.8	1.8	0.073
26-Nov-97	0.7	0.2	<.0002		0.005			<.005	0.0001		0.25		0.065	0.45	1.4	0.038
20-Nov-97				14			5									
16-Oct-97	1.108	0.2	0.0051	1.5	0.007		5	<.005	0.0001		0.258		0.055	0.85	2.4	0.065
18-Sep-97	1.73	0.34	<.0002	0.7	0.003		5	0.01	<.0001		0.73		0.075	1	1.6	0.042
21-Aug-97	1.813	0.47	<.0002	1.8	0.006		6	0.002	<.0001		0.913		0.115	0.9	2	0.056
24-Jul-97	3.02	0.9	0.0002	1.8	0.005		3	0.006	0.0001		1.37		0.075	1.65	2.7	0.036
24-Jun-97	3.02	0.78	<.001	<1	0.016			<.005	<.0005				0.077	1	1.3	0.039
27-May-97	3.02	0.83	<.001	<1	0.014			<.005	<.0005				0.062	1.1	1.5	0.046
29-Apr-97	3.02	0.83	<.001	3	0.01			<.005	<.0005				0.073	1.3	1.2	0.049
18-Mar-97	3.02	0.49	<.001	1	<.01			<.005	<.0005				0.042	0.87	1	0.017
25-Feb-97	3.02	0.285	<.001	4	<.01			<.005	<.0005				0.05	1.4	2.2	<.01
27-Jan-97	3.02	0.52	<.001	3	0.019			<.005	<.0005				0.026	0.87	2.7	0.018
19-Dec-96	3.02	0.36	<.001	6	0.011			<.005	<.0005				0.06	0.98	1.6	0.032
26-Nov-96	3.02	0.465	<.001	18	<.01			<.005	<.0005				0.037	0.79	<1	<.01
31-Oct-96	3.02	0.305	<.001	1	0.013			<.005	<.0005				0.049	0.6	2.2	0.025
27-Sep-96	3.02	0.39	<.001	<1	0.036			<.005	<.0005				0.071	0.84	2.1	0.015
30-Aug-96	3.02	0.17	<.001	<1	0.0082			<.005	<.0005				0.065	0.53	0.9	0.012
31-Jul-96	3.02	0.42	<.001	7	0.011			<.005	<.0005				0.09	0.85	1.7	0.026
21-Jun-96	3.02	0.1	0.001	2.4	0.029		9	0.005	0.0001				0.1	0.5	0.9	0.056
16-May-96	3.02	0.4	0.001	9.1	0.023		4	0.001	0.0001				0.1	0.5	0.7	0.048
08-Mar-96	3.02	0.9	0.001	1.7	0.024		1	0.003	0.0001				0.23	0.5	10	0.052
29-Jan-96	3.02	0.1	0.001	13	0.021		10	0.006	0.0001				0.08	2	5	0.06
08-Jan-96	3.02	0.1	0.0036	17	0.03		10	0.0005	0.0001				0.43	0.1	5	0.032
04-Dec-95	3.02	0.2	0.0005	8.1	0.0005		1	0.001	0.0001				0.35	4.7	0.5	0.13
30-Oct-95	3.02	0.4	0.0005	0.9	0.0005		1	0.0005	0.0001				0.43	1.4	0.5	0.031
28-Sep-95	3.02	0.1	0.0005	1.3	0.013		3	0.003	0.0001				0.13	0.1	0.5	0.004

Port River site 6 *From 28/09/1995 and 28/02/2008*

SAMPLE DATE	Total N (mg/L)	ammonia (as N) (mg/L)	cadmium (total) (mg/L)	chlorophyll a (Ug/L)	copper (total) (mg/L)	dissolved oxygen (mg/L)	entercocci (per 100 mL)	lead (total) (mg/L)	mercury (total) (mg/L)	nickel (total) (mg/L)	oxidised N (as N) (mg/L)	Phosphorus (sol) (mg/L)	phosphorus (total as P) (mg/L)	TKN (as N) (mg/L)	turbidity (NTU)	zinc (total) (mg/L)
28-Feb-08	0.718	0.342	<.0005	2.35	0.0029			0.0006		0.0021	0.138	0.008	0.035	0.58	0.64	0.011
21-Nov-07	1.037	0.344	<.0005	6.85	0.006			0.0012		0.0044	0.297	0.016	0.054	0.74	6.6	0.031
23-Aug-07	1.09	0.322	<.0005	0.91	0.0028			0.0007		0.0021	0.49	0.011	0.028	0.6	2.9	0.014
13-Jun-07	1.034	0.593	<.0005	3.62	0.0039		6	0.0027	<.0003	0.0014	0.284	0.02	0.047	0.75	1.3	0.014
10-May-07	0.99	0.54	<.0005	2.27	0.0029		1	0.0009	<.0003	0.0016	0.28	0.029	0.059	0.71	3.5	0.014
11-Apr-07	0.625	0.134	<.0005	11	0.0014	5.77	3	0.001	<.0003	0.0009	0.105	0.008	0.033	0.52	1.6	0.011
14-Mar-07	0.754	0.13	<.0005	18.5	0.0021		600	0.001	<.0003	0.0012	0.064	0.013	0.035	0.69	6.5	0.013
13-Feb-07	1.122	0.566	<.0005	3.75	0.002		69	0.0007	<.0003	0.001	0.162	0.008	0.04	0.96	4.2	0.015
10-Jan-07	0.511	0.154	<.0005	7.79	0.0021	8.47	76	0.0006	<.0003	0.0013	0.151	<.005	0.034	0.36	2.8	0.013
12-Dec-06	0.34	0.126	<.0005	1.4	0.0023		8	0.0006	<.0003	0.001	0.13	0.011	0.035	0.21	0.78	0.018
17-Nov-06	0.496	0.131	<.0005	1.9	0.0026	8.81	33	0.0008	<.0003	0.001	0.086	0.015	0.046	0.41	1.2	0.023
12-Oct-06	0.89	0.414	<.0005	2.61	0.0037	7.2	1	0.0006	<.0003	0.002	0.28	0.006	0.014	0.61	1.6	0.011
07-Sep-06	0.857	0.36	<.0005	2.62	0.0034	6.7	11	0.0014	<.0003	0.0014	0.237	0.01	0.054	0.62	3.4	0.017
07-Aug-06	0.815	0.221	<.0005	0.76	0.0024	7.5	0	0.0005	<.0003	0.0025	0.285	0.01	0.053	0.53	1.1	0.013
20-Jul-06	1.062	0.447	<.0005	0.73	0.0045	6.8	5	0.0006	<.0003	0.0026	0.392	0.011	0.038	0.67	1.1	0.012
08-Jun-06	1.107	0.651	<.005	1.74	<.01	5.8	1	<.005	<.0003	<.005	0.337	0.007	0.033	0.77	1.6	0.163
02-May-06	0.609	0.231	<.005	3.03	<.01	5.2	14	<.005	<.0003	<.005	0.169	0.01	0.038	0.44	2.9	<.03
03-Apr-06	0.504	0.228	<.005	5.91	<.01	5.9	5	<.005	<.0003	<.005	0.104	<.005	0.042	0.4	1.8	0.034
07-Mar-06	0.72	0.453	<.005	8.35	<.01	5	4	<.005	<.0003	<.005	0.18	0.008	0.029	0.54	1.8	<.03
13-Feb-06	0.663	0.349	<.005	3.35	<.01	5.6	4	<.005	<.0003	<.005	0.123	0.006	0.037	0.54	2.4	<.03
17-Jan-06	0.385	0.01	<.005	4.57	<.01	4.5	4	<.005	<.0003	<.005	0.165	0.006	0.015	0.22	2.6	<.03
08-Dec-05	0.55	0.43	<.005	7.57	<.01	6.2	2	<.005	<.0003	<.005	0.14	<.005	0.032	0.41	2	<.03
17-Nov-05	0.723	0.311	<.005	16.7	<.01	8.4	3	<.005	<.0003	0.006	0.123	<.005	0.024	0.6	3.1	<.03
06-Oct-05	0.656	0.486	<.005	6.86	0.011	6.3	1	<.005	<.0003	0.0147	0.156	0.016	0.47	0.5	3.17	0.036
01-Sep-05	1.329	0.209	<.005	5.5	0.0349	6.9	32	<.005	<.0003	<.005	0.279	0.01	0.05	1.05	1.86	0.04
11-Aug-05	0.92	0.25	<.005	2.3	0.0536	7.6	62	<.005	<.0003	<.005	0.31	0.014	0.05	0.61	2.49	0.0474
13-Jul-05	0.92	0.601	<.005	1.7	0.0397	6.5	37	<.005	<.0003	<.005	0.373	0.024	0.043		1.27	0.0365
09-Jun-05	0.846	0.499	<.005	2.48	0.0214	7	2	<.005	<.0003	<.005	0.226	0.018	0.038	0.62	1.87	0.039
05-May-05	1.159	0.602	<.005	3.5	0.0308	4.1	1	<.005	<.0003	<.005	0.229	0.022	0.07	0.93	3.34	0.0634
06-Apr-05	0.646	0.435	<.005	4.22	0.0166	6.5	4	<.005	<.0003	<.005	0.166	0.017	0.06	0.48	2.12	0.0506
18-Mar-05	0.749	0.518	<.005	2.09	<.01	5.9	18	<.005	<.0003	<.005	0.129	0.02	0.05	0.62	1.59	<.03
15-Feb-05	0.625	0.273	<.002	4.22	<.01		14	<.005	<.0003	<.02	0.115	0.016	0.061	0.51	1.4	<.03
18-Jan-05	0.752	0.27	0.0069	2.59	0.0273		3	<.005	<.0003		0.162		0.067	0.59	1.34	<.03
21-Dec-04	0.956	0.256	0.0061	7.81	0.021		3	<.005	<.0003		0.246		0.08	0.71	4.27	<.03
23-Nov-04	0.699	0.113	<.005	7.69	<.01		1	<.005	<.0003		0.179		0.041	0.52	1.54	<.03
21-Oct-04	1.153	0.44	<.005	5.9	<.01		6	<.005	<.0003		0.363		0.054	0.79	1.45	<.03
15-Sep-04	1.206	0.367	<.005	1.1	<.01		51	<.005	<.0003		0.466		0.09	0.74	2.36	<.03
18-Aug-04	1.111	0.367	<.005	1	<.01		63	<.005	<.0003		0.491		0.096	0.62	1.96	0.1057
19-Jul-04	1.44	0.431	<.005	0.71	<.01		29	<.005	<.0003		0.74		0.104	0.7	1.31	<.03
17-Jun-04	1.472	0.548	<.005	1.55	<.01		50	<.005	<.0003		0.552		0.143	0.92	1.72	<.03
19-May-04	1.104	0.437	<.005	1.2	0.0376		70	<.005	<.0003		0.394		0.099	0.71	1.38	<.03
19-Apr-04	1.174	0.458	<.005	1.56	<.01		3	<.005	<.0003		0.314		0.097	0.86	1.58	<.03
18-Mar-04	0.85	<.25	<.005	4.89	<.01		19	<.005	<.0003		0.237		0.092	0.613	1.35	<.03
05-Feb-04	0.733	0.198	<.005	1.74	<.01		32	<.005	<.0003		0.073		0.073	0.66	0.695	<.03
08-Jan-04	0.746	0.154	0.008	1.58	<.01		8	<.005	<.0003		0.106		0.089	0.64	1.08	<.03
04-Dec-03	1.25	0.333	<.005	15	<.01		28	<.005	<.0003		0.4		0.077	0.85	0.76	<.03
03-Nov-03	0.907	0.209	<.005	2.28	<.01		99	<.005	<.0003		0.337		0.069	0.57	1.02	<.03
30-Oct-03	0.835	0.165	<.005	2.41	<.01		6	<.005	<.0003		0.325		0.071	0.51	0.972	<.03
11-Sep-03	1.235	0.312	<.005	2.6	<.011		13	<.005	<.0003		0.555		0.085	0.68	2.76	0.0786
14-Aug-03	1.54	0.546	<.005	1.23	<.01		20	<.005	0.0003		0.68		0.076	0.86	1.9	<.03
17-Jul-03	1.242	0.487	<.005	0.94	<.01		2	<.005	<.0003		0.492		0.095	0.75	0.983	<.03
19-Jun-03	1.881	0.992	<.005	0.78	<.01		8	<.005	<.0003		0.531		0.11	1.35	1.73	<.03
15-May-03	1.474	0.576	<.005	1.12	<.01		10	<.005	0.0004		0.496		0.082	0.978	1.02	<.03
30-Apr-03	1.741	0.89	<.005	5.36	<.01		5	<.005	<.0003		0.331		0.092	1.41	1.59	<.03
22-Mar-03	1.524	0.435	<.005	2.8	<.01		19	<.005	<.0003		0.334		0.09	1.19	0.66	<.03
25-Feb-03	1.368	0.533	<.005	4.4	<.01		33	<.005	<.0003		0.288		0.114	1.08	1.25	<.03
10-Jan-03	1.325	0.431	<.005	8.4	<.01		27	<.005	<.0003		0.365		0.08	0.96	1.43	<.03
19-Dec-02	1.104	0.264	<.005	2.69	<.01		17	<.005	<.0003		0.314		0.12	0.79	4.44	<.03
14-Nov-02	1.599	0.435	<.005	3.4	<.01		4	<.005	<.0003		0.519		0.072	1.08	1.75	<.03
28-Oct-02	1.372	0.245	<.005	4.04	<.01		25	<.005	0.0006		0.562		0.086	0.81	1.82	<.03
27-Sep-02	1.18	0.359	<.005	3.47	<.01		4	<.005	<.0003		0.39		0.054	0.79	3.24	<.03
15-Aug-02	1.1593	0.333	<.005	1.86	<.01		2	<.005	<.0003		0.4193		0.065	0.74	0.868	<.03
26-Jul-02	1.6216	0.737	<.005	0.74	0.01		40	<.005	<.0003		0.6316		0.086	0.99	1.65	0.0315
29-Jun-02	1.341	0.462	<.005	0.9	<.01		5	<.005	<.0003		0.551		0.092	0.79	0.671	<.03
11-Apr-02	1.1899	0.431	<.005	2.3	<.01		26	<.005	<.0003		0.2999		0.076	0.89	1.25	<.03
14-Mar-02	0.816	0.213	<.005	3.57	<.01		15	<.005	<.0003		0.196		0.089	0.62	2.56	<.03
21-Feb-02	1.2693	0.523	<.005	6.91	<.01		7	<.005	<.0003		0.3793		0.078	0.89	1.405	<.03
31-Jan-02	1.3561	0.39	<.005	11.26	0.0273		140	<.005	<.0003		0.2861		0.101	1.07	1.95	<.03
06-Dec-01	1.2339	0.563	<.005	8.24	<.01		7	<.005	<.0003		0.3339		0.082	0.9	2.95	<.03
08-Nov-01	1.2155	0.653	<.005	4.08	<.01		9	<.005	0.0016		0.3155		0.08	0.9	2.67	<.03
25-Oct-01	0.5408	<.2	<.004	3.39	<.01		0	<.05	<.0003		0.1208		0.052	0.42	1.83	<.1
30-Aug-01	1.888	0.6	<.0004	5.66	0.0101		62	<.005	<.0003		0.788		0.14	1.1	16.6	<.01
02-Aug-01	1.9325	0.753	<.0004	1.17	0.008		0	<.005	<.0003		0.9325		0.094	1	1.4	<.01
24-May-01	1.415	0.546	<.0004	0.99	0.002		22	<.005	<.0003		0.565		0.083	0.85	1.05	<.01
29-Mar-01	1.4225	0.712	<.0004	4.25	0.004		14	<.005	<.0003		0.2225		0.083	1.2	4.06	<.01
22-Feb-01	1.0831	0.414	<.0004	18.96	0.0737		9	0.007	<.0003		0.1631		0.076	0.92	2.07	<.01
30-Jan-01	1.466	0.699	<.0004	22	0.002		24	<.005	<.0003		0.266		0.097	1.2	2.9	<.01
07-Dec-00	0.8115	0.218	<.0004	3.3	0.003		23	<.005	0.0004		0.3315		0.088	0.48	6.57	<.01
26-Oct-00	0.9027	0.224	0.0005	1.62	0.003		21	<.005	<.0003		0.4027		0.08	0.5	0.986	<.01
10-Aug-00	1.854	0.639	<.0004	1.18	0.003		8	<.005	<.0003		0.854		0.1	1	0.928	<.01
04-Jul-00	1.602	0.595	<.0004	1.8	<.002		8	0.007	<.0003		0.732		0.095	0.87	4.12	<.01
08-Jun-00	1.52	0.696	<.0004	0.92	0.001		5	<.005	<.0003		0.68		0.086	0.84	2.17	<.01
18-May-00	1.322	0.51	<.0004	1.69	0.003		9	<.005	<.0003		0.502		0.83	0.82	1.77	<.01
13-Apr-00	1.261	0.575	<.0004	1.18	0.001		11	<.005	<.0003		0.531		0.065	0.73	0.971	<.01
20-Mar-00	1.233	0.429	<.0004	5.18	0.003		0	<.005	<.0003		0.463		0.066	0.77	1.76	0.0429
24-Feb-00	1.216	0.63	<.0004	6.75	0.001		11	<.005	<.0003		0.356		0.094	0.86	1.84	0.0395
20-Jan-00	1.114	0.265	<.0004	24.41	<.001		4	<.005	<.0003		0.444		0.072	0.67	1.78	0.0534
23-Dec-99	0.778	<.1	<.0004	32.9	0.002		21	<.005	<.0003		0.278		0.055	0.5	3	0.0584
25-Nov-99	1.294	0.47	<.0004	4.41	0.004		1	<.005	<.0003		0.564		0.039	0.73	2.05	0.0188
14-Oct-99	1.027	0.26	<.0004	1.53	0.006		120	<.005	<.0003		0.487		0.071	0.54	4.48	0.0182
08-Sep-99	1.684	0.482	<.0004	5.2	0.005		2	<.005	<.0003		0.714		0.106	0.97	17.5	0.0263
05-Aug-99	2.25	1.39	<.0004	2.65	0.0059		4	<.005	<.0003		0.85		0.058	1.4	1.86	0.0062
10-Jun-99	1.752	0.795	<.0005	1.18	0.0036		6	<.005	<.0005		0.782		0.07	0.97	2.4	0.0296

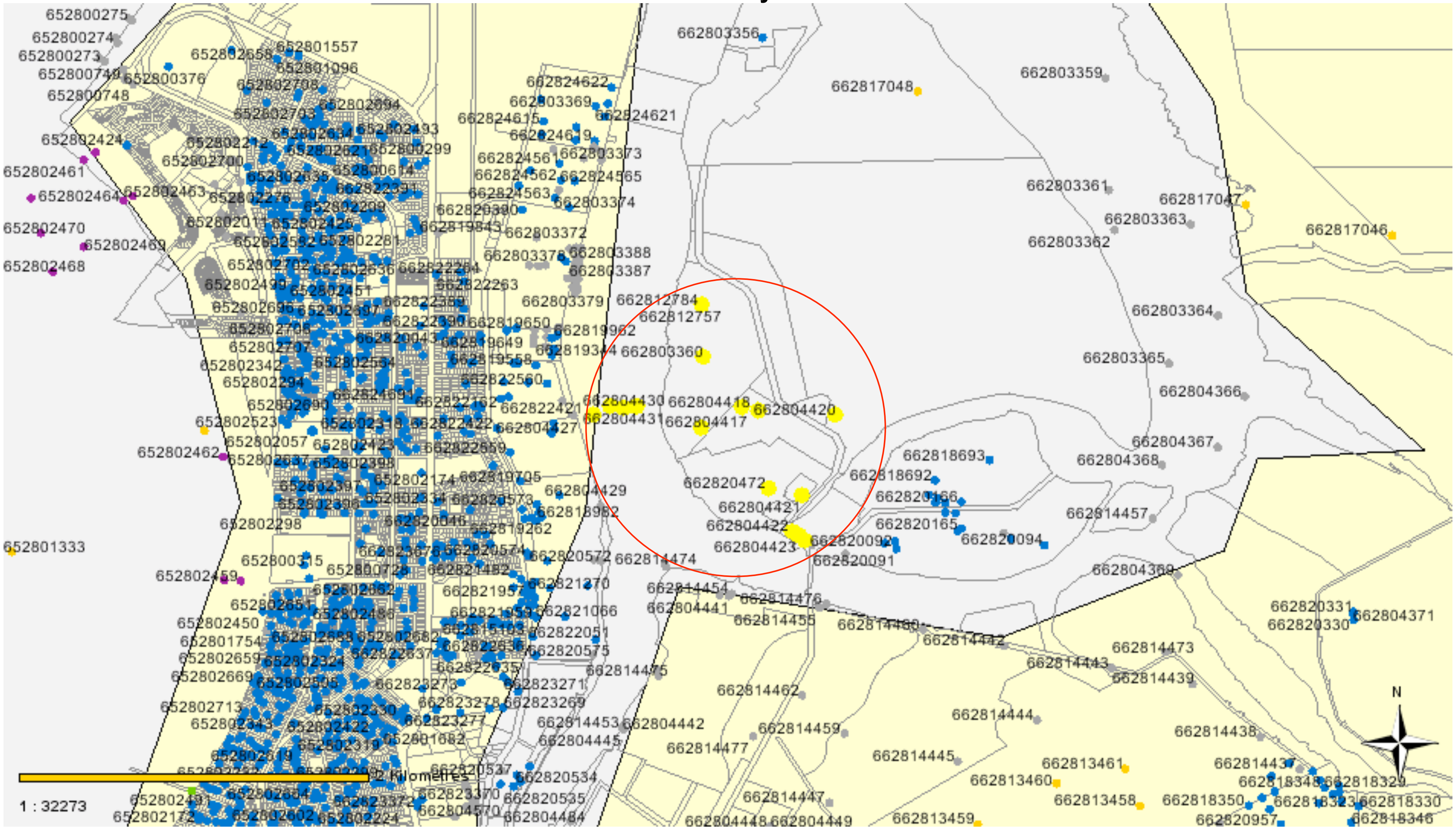
13-May-99	1.536	0.58	<.0004	1.4	0.001		14	<.005	<.0003		0.736		0.076	0.8	2.8	0.033
29-Apr-99	1.657	0.75	<.0004	2.25	0.0043		10	<.005	<.0003		0.747		0.068	0.91	3.52	0.0531
11-Mar-99	2.045	0.87	<.0004		0.0055			0.009	<.001		0.645		0.081	1.4	4.53	0.024
04-Feb-99	1.222	0.52	<.0002	17.5	0.004		25	<.005	<.0001		0.472		0.057	0.75	1.9	0.084
07-Jan-99	1.848	1.03	<.0002	12.57	0.003		17	<.005	<.0001		0.548		0.05	1.3	4.2	0.062
12-Nov-98	1.946	0.92	<.0002	3.77	0.004		65	<.005	<.0001		0.846		0.061	1.1	2.02	0.011
03-Sep-98	1.66	0.476	<.0002	1.23	0.003		7	<.005	<.0001		1.06		0.063	0.6	1.7	0.026
12-Aug-98	1.728	0.87	<.0002	2.31	0.003		8	<.005	<.0001		0.808		0.049	0.92	2.01	0.014
02-Jul-98	0.891	0.275	<.0002	1.02	0.0022		9	<.005	<.0001		0.481		0.052	0.41	1.2	0.1359
28-May-98	1.185	0.74	<.0002	1.08	0.003		9	<.005	<.0001		0.705		0.06	0.48	1.3	0.117
30-Apr-98	0.437	0.255	<.0002	3.56	0.002		22	<.005	<.0001		0.237		<.02	<.2	2	0.032
05-Mar-98	1.39	0.69	<.0002	3.3	0.003		20	<.005	<.0001		0.39		0.104	1	1.2	0.122
12-Feb-98	0.9	0.315	<.0002	17	0.002		12	<.005	<.0001		0.24		0.049	0.66	1.4	0.028
22-Jan-98	1.16	0.39	<.0002	4.9	0.003		46	<.005	<.0001		0.34		0.05	0.82	0.83	0.042
19-Dec-97	1.089	0.4	<.0002	5.9	0.003		18	<.005	<.0001		0.339		0.05	0.75	3	0.032
26-Nov-97	1.005	0.26	<.0002		0.003			0.014	<.0001		0.205		0.065	0.8	1.1	0.06
20-Nov-97				25			8									
16-Oct-97	1.313	0.12	0.0019	1.5	0.01		3	<.005	0.0001		0.163		0.055	1.15	1.2	0.07
18-Sep-97	1.638	0.47	<.0002	1.3	0.003		1	0.007	<.0001		0.688		0.09	0.95	1.3	0.045
21-Aug-97	1.905	0.47	0.0004	3.8	0.01		3	<.001	<.0001		0.905		0.115	1	3.2	0.032
24-Jul-97	3.2	0.8	0.0004	2.2	0.007		1	0.003	<.0001		1.35		0.105	1.85	4.8	0.029
24-Jun-97	3.2	1.35	<.001	2	0.016			<.005	<.0005				0.27	1.9	1.1	0.045
27-May-97	3.2	0.67	<.001	<1	0.013			<.005	<.0005				0.089	0.88	1.2	0.034
29-Apr-97	3.2	0.64	<.001	1	0.011			<.005	<.0005				0.051	1.2	0.9	0.057
18-Mar-97	3.2	0.42	<.001	2	<.01			<.005	<.0005				0.044	0.83	0.7	0.021
25-Feb-97	3.2	0.88	<.001	4	<.01			<.005	<.0005				0.066	1.2	1.6	<.01
27-Jan-97	3.2	0.44	<.001	3	0.021			<.005	<.0005				0.063	0.98	1	0.023
19-Dec-96	3.2	0.22	<.001	9	0.01			<.005	<.0005				0.047	0.79	1.1	0.037
26-Nov-96	3.2	0.44	<.001	1	<.01			<.005	<.0005				0.057	1.1	5.5	<.01
31-Oct-96	3.2	0.31	<.001	1	0.013			<.005	<.0005				0.048	0.68	1.2	0.026
27-Sep-96	3.2	0.445	<.001	<1	0.035			<.005	<.0005				0.067	0.92	0.5	0.038
30-Aug-96	3.2	0.375	<.001	1	0.0075			<.005	<.0005				0.07	0.73	1.6	0.011
31-Jul-96	3.2	0.71	<.001	11	0.012			<.005	<.0005				0.07	1	3.7	0.023
21-Jun-96	3.2	0.1	0.001	1.5	0.028		10	0.006	0.0001				0.1	0.5	1	0.051
16-May-96	3.2	0.6	0.001	0.8	0.023		9	0.001	0.0001				0.1	0.5	0.5	0.056
08-Mar-96	3.2	0.3	0.001	5.8	0.021		1	0.002	0.0001				0.1	0.5	10	0.048
29-Jan-96	3.2	0.3	0.001	4.2	0.02		1	0.004	0.0002				0.09	2	5	0.047
08-Jan-96	3.2	0.1	0.004	17	0.042		7	0.004	0.0001				0.34	0.1	4	0.039
04-Dec-95	3.2	0.2	0.0005	0.1	0.049		1	0.001	0.0001				0.41	0.1	0.5	0.062
30-Oct-95	3.2	0.5	0.0005	1.6	0.0005		8	0.0005	0.0001				0.33	1.4	0.5	0.038
28-Sep-95	3.2	0.1	0.0005	0.8	0.0087		1	0.0005	0.0001				0.125	0.1	0.5	0.008

Appendix B
DWLBC Borehole Search Results

Surface Water and Groundwater Assessment
Torrens Island Power Station Proposed Expansion
Torrens Island

Appendix B

Boreholes within 1km radius of the North-western Site Boundary



APPENDIX B
Drillholes within 1 kilometre radius of the Site

Unit_No	drillhole name	class	orig drill depth	orig drill date	max drill depth	max drill date	late open depth	late open date	late permit no	cased to	case min diam	purpose	late status	late status date	SWL	RSWL	water level date	TDS	EC	salinity date	pH	pH date	yield	yield date	mga easting	mga northing
6628-3360	TORRENS IS5	WW EW	15.24	15/5/62	15.24	15/5/62	15.24	15/5/62				EXP	UKN	15/5/62	1.22	0.78	15/5/62	1226	2218	31/5/62					272976.8	6146545.3
6628-3377	FOUNDATION TESTI	WW EW	7.62	11/3/58	7.62	11/3/58	7.62	11/3/58				EXP	ABD		2.23	1.95	11/3/58								272177.7	6146218.3
6628-4417	TORRENS IS4	EW	15.24	9/5/62	15.24	9/5/62	15.24	9/5/62					UKN	9/5/62	0.91	0.25	9/5/62								272977.7	6146051.3
6628-4418	TORRENS IS1	EW	45.72	11/4/62	45.72	11/4/62	45.72	11/4/62					UKN	11/4/62	2.29	0.6	11/4/62								273207.7	6146200.3
6628-4419	TORRENS IS6	EW	12.19	18/5/62	12.19	18/5/62	12.19	18/5/62		12.19	102		UKN	18/5/62	1.22	1.89	18/5/62								273303.7	6146179.3
6628-4420	TORRENS IS3	EW	15.54	4/5/62	15.54	4/5/62	15.54	4/5/62					UKN	4/5/62	0.3	0.57	4/5/62								273744.8	6146160.3
6628-4421	TORRENS IS2	EW	45.72	29/4/62	45.72	29/4/62	45.72	29/4/62					UKN	29/4/62	2.9	-0.11	29/4/62								273566.8	6145596.2
6628-4422		EW	7.62	22/10/64	7.62	22/10/64	7.62	22/10/64					UKN	22/10/64											273516.7	6145343.3
6628-4423		EW	4.27	23/10/64	4.27	23/10/64	4.27	23/10/64					UKN	23/10/64											273557.7	6145318.3
6628-4424		EW	7.62	26/10/64	7.62	26/10/64	7.62	26/10/64					UKN	26/10/64											273592.7	6145283.3
6628-4425	KWG SMITH	EW	7.62	27/10/64	7.62	27/10/64	7.62	27/10/64					UKN	27/10/64											273630.8	6145252.3
6628-4430	BECHTEL PACIFIC	EW	6.86	17/3/68	6.86	17/3/68	6.86	17/3/68					UKN	17/3/68											272451.8	6146190.2
6628-4431	BECHTEL PACIFIC	EW	12.19	12/3/68	12.19	12/3/68	12.19	12/3/68					UKN	12/3/68											272530.7	6146179.3
6628-4432	BECHTEL PACIFIC	EW	4.57	6/3/68	4.57	6/3/68	4.57	6/3/68					UKN	6/3/68											272606.7	6146193.3
6628-4433	BECHTEL PACIFIC	EW	19.96	29/2/68	19.96	29/2/68	19.96	29/2/68					UKN	29/2/68											272245.7	6146119.3
6628-4434	BECHTEL PACIFIC	EW	10.97	15/3/68	10.97	15/3/68	10.97	15/3/68					UKN	15/3/68											272359.8	6146127.2
6628-4435	BECHTEL PACIFIC	EW	3.35	6/3/68	3.35	6/3/68	3.35	6/3/68					ABD												272605.7	6146189.3
6628-12682	DH 1	MW	2	17/7/81	2	17/7/81	2	17/7/81																	272959.7	6146908.4
6628-12683	DH 2	MW	2.2	17/7/81	2.2	17/7/81	2.2	17/7/81							1.8	1.79	17/7/81								272959.7	6146908.4
6628-12684	DH 3	MW	1.5	17/7/81	1.5	17/7/81	1.5	17/7/81							1.3	2.29	17/7/81								272959.7	6146908.4
6628-12685	DH 4	MW	1.5	17/7/81	1.5	17/7/81	1.5	17/7/81							1.3	2.29	17/7/81								272959.7	6146908.4
6628-12686	DH 5	MW	3	17/7/81	3	17/7/81	3	17/7/81							0	3.59	17/7/81								272959.7	6146908.4
6628-12687	DH 6	MW	2	17/7/81	2	17/7/81	2	17/7/81																	272959.7	6146908.4
6628-12688	DH 7	MW	2	17/7/81	2	17/7/81	2	17/7/81																	272959.7	6146908.4
6628-12689	DH 8	MW	2	17/7/81	2	17/7/81	2	17/7/81							2	1.59	17/7/81								272959.7	6146908.4
6628-12690	DH 9	MW	3	17/7/81	3	17/7/81	3	17/7/81							2.6	0.99	17/7/81								272959.7	6146908.4
6628-12691	DH 10	MW	3	17/7/81	3	17/7/81	3	17/7/81																	272959.7	6146908.4
6628-12692	DH 11	MW	1.4	17/7/81	1.4	17/7/81	1.4	17/7/81							0.8	2.79	17/7/81								272959.7	6146908.4
6628-12693	DH 12	MW	1.5	17/7/81	1.5	17/7/81	1.5	17/7/81							1.3	2.29	17/7/81								272959.7	6146908.4
6628-12694	DH 13	MW	1.5	17/7/81	1.5	17/7/81	1.5	17/7/81							1.2	2.39	17/7/81								272959.7	6146908.4
6628-12695	DH 14	MW	3	17/7/81	3	17/7/81	3	17/7/81							2	1.59	17/7/81								272959.7	6146908.4
6628-12696	DH 15	MW	3	17/7/81	3	17/7/81	3	17/7/81																	272959.7	6146908.4
6628-12697	DH 16	MW	2.5	17/7/81	2.5	17/7/81	2.5	17/7/81							2.5	1.09	17/7/81								272959.7	6146908.4
6628-12698	DH 17	MW	3	17/7/81	3	17/7/81	3	17/7/81																	272959.7	6146908.4
6628-12699	DH 18	MW	3	17/7/81	3	17/7/81	3	17/7/81							2.8	0.79	17/7/81								272959.7	6146908.4
6628-12700	DH 19	MW	3	17/7/81	3	17/7/81	3	17/7/81							2.8	0.79	17/7/81								272959.7	6146908.4
6628-12701	DH 20	MW	3	17/7/81	3	17/7/81	3	17/7/81							3	0.59	17/7/81								272959.7	6146908.4
6628-12702	DH 21	MW	2.5	17/7/81	2.5	17/7/81	2.5	17/7/81							2.5	1.09	17/7/81								272959.7	6146908.4
6628-12703	DH 22	MW	1.5	17/7/81	1.5	17/7/81	1.5	17/7/81							1.5	2.09	17/7/81								272959.7	6146908.4
6628-12704	DH 23	MW	1.5	17/7/81	1.5	17/7/81	1.5	17/7/81							1.3	2.29	17/7/81								272959.7	6146908.4
6628-12705	DH 24	MW	1.2	17/7/81	1.2	17/7/81	1.2	17/7/81							1.2	2.39	17/7/81								272959.7	6146908.4
6628-12706	DH 25	MW	3	17/7/81	3	17/7/81	3	17/7/81							3	0.59	17/7/81								272959.7	6146908.4
6628-12707	DH 26	MW	2	17/7/81	2	17/7/81	2	17/7/81							1.6	1.99	17/7/81								272959.7	6146908.4
6628-12708	DH 27	MW	1.5	17/7/81	1.5	17/7/81	1.5	17/7/81							1.2	2.39	17/7/81								272959.7	6146908.4
6628-12709	DH 28	MW	1.5	17/7/81	1.5	17/7/81	1.5	17/7/81							1.3	2.29	17/7/81								272959.7	6146908.4
6628-12710	DH 29	MW	0.8	17/7/81	0.8	17/7/81	0.8	17/7/81							0.8	2.79	17/7/81								272959.7	6146908.4
6628-12711	DH 30	MW	3	17/7/81	3	17/7/81	3	17/7/81							2.8	0.79	17/7/81								272959.7	6146908.4
6628-12712	DH 31	MW	2.5	17/7/81	2.5	17/7/81	2.5	17/7/81							2.3	1.29	17/7/81								272959.7	6146908.4
6628-12713	DH 32	MW	3	17/7/81	3	17/7/81	3	17/7/81							3	0.59	17/7/81								272959.7	6146908.4
6628-12714	DH 33	MW	1.5	17/7/81	1.5	17/7/81	1.5	17/7/81							1.4	2.19	17/7/81								272959.7	6146908.4
6628-12715	DH 34	MW	1.5	17/7/81	1.5	17/7/81	1.5	17/7/81							1.1	2.49	17/7/81								272959.7	6146908.4
6628-12716	DH 35	MW	0.8	17/7/81	0.8	17/7/81	0.8	17/7/81							0.8	2.79	17/7/81								272959.7	6146908.4
6628-12717	DH 36	MW	1.1	17/7/81	1.1	17/7/81	1.1	17/7/81							1.1	2.49	17/7/81								272959.7	6146908.4
6628-12718	DH 37	MW	1.4	17/7/81	1.4	17/7/81	1.4	17/7/81							1.4	2.19	17/7/81								272959.7	6146908.4
6628-12719	DH 38	MW	4.5	17/7/81	4.5	17/7/81	4.5	17/7/81							3.6	-0.01	17/7/81								272959.7	6146908.4
6628-12720	DH 39	MW	4.5	17/7/81	4.5	17/7/81	4.5	17/7/81																	272959.7	6146908.4
6628-12721	DH 40	MW	4.5	17/7/81	4.5	17/7/81	4.5	17/7/81																	272959.7	6146908.4
6628-12722	DH 41	MW	4.5	17/7/81	4.5	17/7/81	4.5	17/7/81							4	-0.41	17/7/81								272959.7	6146908.4
6628-12723	DH 42	MW	4.5	17/7/81	4.5	17/7/81	4.5	17/7/81																	272959.7	6146908.4
6628-12724	DH 43	MW	3	17/7/81	3	17/7/81	3	17/7/81																	272959.7	6146908.4
6628-12725	DH 44	MW	2.5	17/7/81	2.5	17/7/81	2.5	17/7/81							0	3.59	17/7/81								272959.7	6146908.4
6628-12726	DH 45	MW	1.5	17/7/81	1.5	17/7/81	1.5	17/7/81																	272959.7	6146908.4
6628-12727	DH 46	MW	2	17/7/81	2	17/7/81	2	17/7/81							1.6	1.99	17/7/81								272959.7	6146908.4
6628-12728	DH 47	MW	4.5	17/7/81	4.5	17/7/81	4.5	17/7/81							4.1	-0.51	17/7/81								272959.7	6146908.4
6628-12729	DH 48	MW	4.5	17/7/81	4.5	17/7/81	4.5	17/7/81							4.2	-0.61	17/7/81								272959.7	6146908.4
6628-12730	DH 49	MW	3	17/7/81	3	17/7/81	3	17/7/81							0	3.59	17/7/81								272959.7	6146908.4
6628-12731	DH 50	MW	3.5	17/7/81	3.5	17/7/81	3.5	17/7/81							3.5	0.09	17/7/81								272959.7	6146908.4
6628-12732	DH 51	MW	1.7	17/7/81	1.7	17/7/81	1.7	17/7/81							1.7	1.89	17/7/81								272959.7	6146908.4
6628-12733	DH 52	MW	4.5	17/7/81	4.5	17/7/81	4.5	17/7/81							4.5	-0.91	17/7/81								272959.7	6146908.4
6628-12734	DH 53	MW	2.8	17/7/81	2.8	17/7/81	2.8	17/7/81							2.6	0.99	17/7/81								272959.7	6146908.4
6628-12735	DH 54	MW	4.5	17/7/81	4.5	17/7/81	4.5	17/7/81							4.5	-0.91	17/7/81								272959.7	6146908.4
6628-12736	DH 55	MW	1.5	17/7/81	1.5	17/7/81	1.5	17/7/81							1.1	2.49	17/7/81								272959.7	6146908.4
6628-12737	DH 56	MW	1.5	17/7/81	1.5	17/7/81	1.5	17/7/81							1.3	2.29	17/7/81								272959.7	6146908.4
6628-12738	DH 57	MW	4.5	17/7/81	4.5	17/7/81	4.5	17/7/81							4.5	-0.91	17/7/81								272959.7	6146908.4
6628-12739	DH 58	MW	1.5	17/7/81	1.5	17/7/81	1.5	17/7/81							0.9	2.69	17/7/81								272959.7	6146908.4
6628-12740	DH 59	MW	1.5	17/7/81	1.5	17/7/81	1.5	17/7/81							1.1	2.49	17/7/81								272959.7	6146908.4
6628-12741	DH 60	MW	3	17/7/81	3	17/7/81	3	17/7/81							2.5	1.09	17/7/81								272959.7	6146908.4
6628-12742	DH 61	MW	3	17/7/81	3	17/7/81	3	17/7/81							2.6	0.99	17/7/81								272959.7	6146908.4
6628-12743	DH 62	MW	3	17/7/81	3	17/7/81	3	17/7/81							3	0.59	17/7/81								272959.7	6146908.4
6628-12744	DH 63	MW	4.5	17/7/81	4.5	17/7/81	4.5	17/7/81																	272959.7	6146908.4
6628-12745	DH 64	MW	4.5	17/7/81	4.5	17/7/81	4.5	17/7/81							4.2	-0.61	17/7/81								272959.7	6146908.4
6628-12746	DH 65	MW	3	17/7/81	3	17/7/81	3	17/7/81							0	3.59	17/7/81								272959.7	6146908.4
6628-12747	DH 66	MW	1	17/7/81	1	17/7/81	1	17/7/81							1	2.59	17/7/81								272959.7	6146908.4
6628-12748	DH 67	MW	4.5	17/7/81	4.5	17/7/81	4.5	17/7/81							4.5	-0.91	17/7/81								272959.7	6146908.4
6628-12749	DH 68	MW	4.5	17/7/81	4.5	17/7/81	4.5	17/7/81							4.5	-0.91	17/7/81								272959.7	6146908.4
6628-12750	DH 69	MW	3.3	17/7/81	3.3	17/7/81	3.3	17/7/81							3.3	0.29	17/7/81								272959.7	6146908.4
6628-12751	DH 70	MW	4.5	17/7/81	4.5	17/7/81	4.5	17/7/81							4.5	-0.91	17/7/81								272959.7	6146908.4
6628-12752	DH 71	MW	4.5	17/7/81	4.5	17/7/81	4.5	17/7/81							4.2	-0.61	17/7/81								272959.7	6146908.4
6628-12753	DH 72	MW	3	17/7/81	3	17/7/81	3	17/7/81							3	0.59	17/7/81								272959.7	6146908.4
6628-12754	DH 73	MW	3	17/7/81	3	17/7/81	3	17/7/81							2	1.59	17/7/81								272959.7	6146908.4
6628-12755	DH 74	MW	3	17/7/81	3	17/7/81	3	17/7/81							1.7	1.89	17/7/81								272959.7	6146908.4
6628-12756	DH 75	MW	1.5	17/7/81	1.5	17/7/81	1.5	17/7/81							1.3	2.29	17/7/81								272959.7	6146908.4
6628-12757	DH 76	MW	3	17/7/81	3	17/7/81	3	17/7/81							2.9	0.69	17/7/81								272959.7	6146908.4
6628-12758	DH 77	MW	3	17/7/81	3	17/7/81	3	17/7/81							0	3.59	17/7/81								272959.7	6146908.4
6628-12759	DH 78	MW	4.5	17/7/81	4.5	17/7/81	4.5	17/7/81							4.9	-1.31	17/7/81								272959.7	6146908.4
6628-12760	DH 79	MW	3	17/7/81	3	17/7/81	3	17/7/81							3	0.59	17/7/81								272959.7	6146908.4
6628-12761	DH 80	MW	1.5	17/7/81	1.5	17/7/81	1.5	17/7/81							1.1	2.49	17/7/81								272959.7	6146908.4
6628-12762	DH 81	MW	1.5	17/7/81	1.5	17/7/81	1.5	17/7/81							0.4	3.19	17/7/81								272959.7	6146908.4
6628-12763	DH 82	MW	1.5	17/7/81	1.5	17/7/81	1.5	17/7/81							1.4	2.19	17/7/81								272959.7	6146908.4
6628-12764	DH 83	MW	1.5	17/7/81	1.5	17/7/81	1.5	17/7/81							1.4	2.19	17/7/81								272959.7	6146908.4
6628-12765	DH 84	MW	1.5	17/7/81	1.5	17/7/81	1.5	17/7/81							1.4	2.19	17/7/81								272959.7	6146908.4
6628-12766	DH 85	MW	6	17/7/81	6	17/7/81	6	17/7/81							5.9	-2.31	17/7/81								272959.7	6146908.4
6628-12767	DH 86	MW	3	17/7/81	3	17/7/81	3	17/7/81							3	0.59	17/7/81								272959.7	6146908.4
6628-12768	DH 87	MW	4.5	17/7/81	4.5	17/7/81	4.5	17/7/81							4.5	-0.91	17/7/81								272959.7	6146908.4
6628-12769	DH 88	MW	4.5	17/7/81	4.5	17/7/81	4.5	17/7/81							4.5	-0.91	17/7/81								272959.7	6146908.4
6628-12770	DH 89	MW	3	17/7/81	3	17/7/81	3	17/7/81							2.8	0.79	17/7/81								272959.7	6146908.4
6628-12771	DH 90	MW	3	17/7/81	3	17/7/81	3	17/7/81							2.7	0.89	17/7/81								272959.7	6146908.4
6628-12772	DH 91	MW	3	17/7/81	3	17/7/81	3	17/7/81							2.9	0.69	17/7/81								272959.7	6146908.4
6628-12773	DH 92	MW	4.5	17/7/81	4.5	17/7/81	4.5	17/7/81							2.7	0.89	17/7/81								272959.7	6146908.4
6628-12774	DH 93	MW	3	17/7/81	3	17/7/81	3	17/7/81							3	0.59	17/7/81								272959.7	6146908.4
6628-12775	DH 94	MW	1.5	17/7/81	1.5	17/7/81	1.5	17/7/81							1.5	2.09	17/7/81								272959.7	6146908.4
6628-12776	DH 95	MW	1.5	17/7/81	1.5	17/7/81	1.5	17/7/81							1.3	2.29	17/7/81								272959.7	6146908.4
6628-12777	DH 96	MW	3	17/7/81	3	17/7/81	3	17/7/81																	272959.7	6146908.4
6628-12778	DH 97	MW	4.5	17/7/81	4.5	17/7/81	4.5	17/7/81							4.5	-0.91	17/7/81								272959.7	6146908.4
6628-12779	DH 98	MW	3	17/7/81	3	17/7/81	3	17/7/81							2.7	0.89	17/7/81								272959.7	6146908.4
6628-12780	DH 99	MW	4.5	17/7/81	4.5	17/7/81	4.5	17/7/81							3.7	-0.11	17/7/81								272959.7	6146908.4
6628-12781	DH 100	MW	4.5	17/7/81	4.5	17/7/81	4.5	17/7/81							4.5	-0.91	17/7/81								272959.7	6146908.4
6628-12782	DH 101	MW	4.5	17/7/81	4.5	17/7/81	4.5	17/7/81							4.5	-0.91	17/7/81								272959.7	6146908.4
6628-12783	DH 102	MW	4.5	17/7/81	4.5	17/7/81	4.5	17/7/81							4.5	-0.91	17/7/81								272959.7	6146908.4
6628-12784	DH 103	MW	3	17/7/81	3	17/7/81	3	17/7/81							3	0.59	17/7/81								272959.7	6146908.4
6628-12785	DH 104	MW	3	17/7/81	3	17/7/81	3	17/7/81							2.7	0.89	17/7/81								272959.7	6146908.4
6628-12786	DH 105	MW	4.5	17/7/81	4.5	17/7/81	4.5	17/7/81							4.4	-0.81	17/7/81								272959.7	6146908.4
6628-12787	DH 106	MW	3	17/7/81	3	17/7/81	3	17/7/81							3	0.59	17/7/81								272959.7	6146908.4
6628-12788	DH 107	MW	3	17/7/81	3	17/7/81	3	17/7/81							2	1.59	17/7/81								272959.7	6146908.4
6628-12789	DH 108	MW	3	17/7/81	3	17/7/81	3	17/7/81							1.7	1.89	17/7/81								272959.7	6146908.4
6628-12790	DH 109	MW	1	17/7/81	1	17/7/81	1	17/7/81							1	2.59	17/7/81								272959.7	6146908.4
6628-12791	DH 110	MW	1.5	17/7/81	1.5	17/7/81	1.5	17/7/81							1	2.59	17/7/81								272959.7	6146908.4
6628-14448	VC316	EW	4.69	21/6/89	4.69	21/6/89	4.69	21/6/89					UKN	21/6/89											272414.8	6145491.3
6628-20472		WW	147.5	5/2/01	147.5	5/2/01	147.5	5/2/01	54103	130	203	IND			17.8	-14.9	5/2/01	1681	3030	13/2/01			7	5/2/01	273375.4	6145639.5

APPENDIX B
Drillholes within 1 kilometre radius of the Site

Unit_No	mga zone	long deg	long min	long sec	lat deg	lat min	lat sec	decimal long	decimal lat	neg decimal lat	hundred	plan	parcel	title reference	map 250k	map 100k	map 50k	map 10k	map 2_5k	map 1k	water info	salinity	water chemistry	geophys log	drill log	lith log
6628-3360	54	138	31	6.507	34	47	52.981	138.518474	34.79805	-34.79805	PORT ADELAIDE	D55734	A303	CT 5973 985	SI5409	6628	3	30	r	4	Y	Y	N	N	N	Y
6628-3377	54	138	30	34.77	34	48	2.946	138.509658	34.800818	-34.800818	PORT ADELAIDE	F32808	A102	CT 5851 509	SI5409	6628	3	31	a	2	Y	N	N	N	N	N
6628-4417	54	138	31	6.065	34	48	9.005	138.518351	34.802501	-34.802501	PORT ADELAIDE	D55734	A303	CT 5973 985	SI5409	6628	3	31	a	3	Y	N	N	N	N	N
6628-4418	54	138	31	15.252	34	48	4.357	138.520903	34.80121	-34.80121	PORT ADELAIDE	D55734	Q302	CT 5937 201	SI5409	6628	3	31	a	3	Y	N	N	N	N	N
6628-4419	54	138	31	19.006	34	48	5.116	138.521946	34.801421	-34.801421	PORT ADELAIDE	D55734	Q302	CT 5937 201	SI5409	6628	3	31	a	3	Y	N	N	N	N	N
6628-4420	54	138	31	36.329	34	48	6.085	138.526758	34.80169	-34.80169	PORT ADELAIDE	D55734	Q306	CT 5973 987	SI5409	6628	3	31	b	1	Y	N	N	N	N	N
6628-4421	54	138	31	28.784	34	48	24.236	138.524662	34.806732	-34.806732	PORT ADELAIDE	D55734	Q2001	CT 5861 723	SI5409	6628	3	31	a	4	Y	N	N	N	N	N
6628-4422	54	138	31	26.57	34	48	32.401	138.524047	34.809	-34.809		D55734	A304	CT 5907 395	SI5409	6628	3	31	a	4	N	N	N	N	N	N
6628-4423	54	138	31	28.158	34	48	33.243	138.524488	34.809234	-34.809234		D55734	A304	CT 5907 395	SI5409	6628	3	31	a	4	N	N	N	N	N	N
6628-4424	54	138	31	29.501	34	48	34.406	138.524861	34.809557	-34.809557	PORT ADELAIDE	D55734	A304	CT 5907 395	SI5409	6628	3	31	a	4	N	N	N	N	N	N
6628-4425	54	138	31	30.966	34	48	35.443	138.525268	34.809845	-34.809845	PORT ADELAIDE	D55734	A304	CT 5907 395	SI5409	6628	3	31	b	6	N	N	N	N	N	N
6628-4430	54	138	30	45.52	34	48	4.076	138.512644	34.801132	-34.801132		NOT CODED	BY DEH		SI5409	6628	3	31	a	2	N	N	N	N	N	N
6628-4431	54	138	30	48.612	34	48	4.494	138.513503	34.801248	-34.801248		NOT CODED	BY DEH		SI5409	6628	3	31	a	2	N	N	N	N	N	N
6628-4432	54	138	30	51.614	34	48	4.102	138.514337	34.801139	-34.801139		NOT CODED	BY DEH		SI5409	6628	3	31	a	2	N	N	N	N	N	N
6628-4433	54	138	30	37.348	34	48	6.211	138.510374	34.801725	-34.801725	PORT ADELAIDE	D57880	A12	CT 5980 62	SI5409	6628	3	31	a	2	N	N	N	N	N	N
6628-4434	54	138	30	41.84	34	48	6.046	138.511622	34.801679	-34.801679		NOT CODED	BY DEH		SI5409	6628	3	31	a	2	N	N	N	N	N	N
6628-4435	54	138	30	51.571	34	48	4.231	138.514325	34.801175	-34.801175		NOT CODED	BY DEH		SI5409	6628	3	31	a	2	N	N	N	N	N	N
6628-12682	54	138	31	6.19	34	47	41.194	138.518386	34.794776	-34.794776	PORT ADELAIDE	D55734	A303	CT 5973 985	SI5409	6628	3	30	r	4	N	N	N	N	Y	N
6628-12683	54	138	31	6.19	34	47	41.194	138.518386	34.794776	-34.794776	PORT ADELAIDE	D55734	A303	CT 5973 985	SI5409	6628	3	30	r	4	Y	N	N	N	Y	N
6628-12684	54	138	31	6.19	34	47	41.194	138.518386	34.794776	-34.794776	PORT ADELAIDE	D55734	A303	CT 5973 985	SI5409	6628	3	30	r	4	Y	N	N	N	Y	N
6628-12685	54	138	31	6.19	34	47	41.194	138.518386	34.794776	-34.794776	PORT ADELAIDE	D55734	A303	CT 5973 985	SI5409	6628	3	30	r	4	Y	N	N	N	Y	N
6628-12686	54	138	31	6.19	34	47	41.194	138.518386	34.794776	-34.794776	PORT ADELAIDE	D55734	A303	CT 5973 985	SI5409	6628	3	30	r	4	Y	N	N	N	Y	N
6628-12687	54	138	31	6.19	34	47	41.194	138.518386	34.794776	-34.794776	PORT ADELAIDE	D55734	A303	CT 5973 985	SI5409	6628	3	30	r	4	N	N	N	N	Y	N
6628-12688	54	138	31	6.19	34	47	41.194	138.518386	34.794776	-34.794776	PORT ADELAIDE	D55734	A303	CT 5973 985	SI5409	6628	3	30	r	4	N	N	N	N	Y	N
6628-12689	54	138	31	6.19	34	47	41.194	138.518386	34.794776	-34.794776	PORT ADELAIDE	D55734	A303	CT 5973 985	SI5409	6628	3	30	r	4	Y	N	N	N	Y	N
6628-12690	54	138	31	6.19	34	47	41.194	138.518386	34.794776	-34.794776	PORT ADELAIDE	D55734	A303	CT 5973 985	SI5409	6628	3	30	r	4	Y	N	N	N	Y	N
6628-12691	54	138	31	6.19	34	47	41.194	138.518386	34.794776	-34.794776	PORT ADELAIDE	D55734	A303	CT 5973 985	SI5409	6628	3	30	r	4	N	N	N	N	Y	N
6628-12692	54	138	31	6.19	34	47	41.194	138.518386	34.794776	-34.794776	PORT ADELAIDE	D55734	A303	CT 5973 985	SI5409	6628	3	30	r	4	Y	N	N	N	Y	N
6628-12693	54	138	31	6.19	34	47	41.194	138.518386	34.794776	-34.794776	PORT ADELAIDE	D55734	A303	CT 5973 985	SI5409	6628	3	30	r	4	Y	N	N	N	Y	N
6628-12694	54	138	31	6.19	34	47	41.194	138.518386	34.794776	-34.794776	PORT ADELAIDE	D55734	A303	CT 5973 985	SI5409	6628	3	30	r	4	Y	N	N	N	Y	N
6628-12695	54	138	31	6.19	34	47	41.194	138.518386	34.794776	-34.794776	PORT ADELAIDE	D55734	A303	CT 5973 985	SI5409	6628	3	30	r	4	Y	N	N	N	Y	N
6628-12696	54	138	31	6.19	34	47	41.194	138.518386	34.794776	-34.794776	PORT ADELAIDE	D55734	A303	CT 5973 985	SI5409	6628	3	30	r	4	N	N	N	N	Y	N
6628-12697	54	138	31	6.19	34	47	41.194	138.518386	34.794776	-34.794776	PORT ADELAIDE	D55734	A303	CT 5973 985	SI5409	6628	3	30	r	4	Y	N	N	N	Y	N
6628-12698	54	138	31	6.19	34	47	41.194	138.518386	34.794776	-34.794776	PORT ADELAIDE	D55734	A303	CT 5973 985	SI5409	6628	3	30	r	4	N	N	N	N	Y	N
6628-12699	54	138	31	6.19	34	47	41.194	138.518386	34.794776	-34.794776	PORT ADELAIDE	D55734	A303	CT 5973 985	SI5409	6628	3	30	r	4	Y	N	N	N	Y	N
6628-12700	54	138	31	6.19	34	47	41.194	138.518386	34.794776	-34.794776	PORT ADELAIDE	D55734	A303	CT 5973 985	SI5409	6628	3	30	r	4	Y	N	N	N	Y	N
6628-12701	54	138	31	6.19	34	47	41.194	138.518386	34.794776	-34.794776	PORT ADELAIDE	D55734	A303	CT 5973 985	SI5409	6628	3	30	r	4	Y	N	N	N	Y	N
6628-12702	54	138	31	6.19	34	47	41.194	138.518386	34.794776	-34.794776	PORT ADELAIDE	D55734	A303	CT 5973 985	SI5409	6628	3	30	r	4	Y	N	N	N	Y	N
6628-12703	54	138	31	6.19	34	47	41.194	138.518386	34.794776	-34.794776	PORT ADELAIDE	D55734	A303	CT 5973 985	SI5409	6628	3	30	r	4	Y	N	N	N	Y	N
6628-12704	54	138	31	6.19	34	47	41.194	138.518386	34.794776	-34.794776	PORT ADELAIDE	D55734	A303	CT 5973 985	SI5409	6628	3	30	r	4	Y	N	N	N	Y	N
6628-12705	54	138	31	6.19	34	47	41.194	138.518386	34.794776	-34.794776	PORT ADELAIDE	D55734	A303	CT 5973 985	SI5409	6628	3	30	r	4	Y	N	N	N	Y	N
6628-12706	54	138	31	6.19	34	47	41.194	138.518386	34.794776	-34.794776	PORT ADELAIDE	D55734	A303	CT 5973 985	SI5409	6628	3	30	r	4	Y	N	N	N	Y	N
6628-12707	54	138	31	6.19	34	47	41.194	138.518386	34.794776	-34.794776	PORT ADELAIDE	D55734	A303	CT 5973 985	SI5409	6628	3	30	r	4	Y	N	N	N	Y	N
6628-12708	54	138	31	6.19	34	47	41.194	138.518386	34.794776	-34.794776	PORT ADELAIDE	D55734	A303	CT 5973 985	SI5409	6628	3	30	r	4	Y	N	N	N	Y	N
6628-12709	54	138	31	6.19	34	47	41.194	138.518386	34.794776	-34.794776	PORT ADELAIDE	D55734	A303	CT 5973 985	SI5409	6628	3	30	r	4	Y	N	N	N	Y	N
6628-12710	54	138	31	6.19	34	47	41.194	138.518386	34.794776	-34.794776	PORT ADELAIDE	D55734	A303	CT 5973 985	SI5409	6628	3	30	r	4	Y	N	N	N	Y	N
6628-12711	54	138	31	6.19	34	47	41.194	138.518386	34.794776	-34.794776	PORT ADELAIDE	D55734	A303	CT 5973 985	SI5409	6628	3	30	r	4	Y	N	N	N	Y	N
6628-12712	54	138	31	6.19	34	47	41.194	138.518386	34.794776	-34.794776	PORT ADELAIDE	D55734	A303	CT 5973 985	SI5409	6628	3	30	r	4	Y	N	N	N	Y	N
6628-12713	54	138	31	6.19	34	47	41.194	138.518386	34.794776	-34.794776	PORT ADELAIDE	D55734	A303	CT 5973 985	SI5409	6628	3	30	r	4	Y	N	N	N	Y	N
6628-12714	54	138	31	6.19	34	47	41.194	138.518386	34.794776	-34.794776	PORT ADELAIDE	D55734	A303	CT 5973 985	SI5409	6628	3	30	r	4	Y	N	N	N	Y	N
6628-12715	54	138	31	6.19	34	47	41.194	138.518386	34.794776	-34.794776	PORT ADELAIDE	D55734	A303	CT 5973 985	SI5409	6628	3	30	r	4	Y	N	N	N	Y	N
6628-12716	54	138	31	6.19	34	47	41.194	138.518386	34.794776	-34.794776	PORT ADELAIDE	D55734	A303	CT 5973 985	SI5409	6628	3	30	r	4	Y	N	N	N	Y	N
6628-12717	54	138	31	6.19	34	47	41.194	138.518386	34.794776	-34.794776	PORT ADELAIDE	D55734	A303	CT 5973 985	SI5409	6628	3	30	r	4	Y	N	N	N	Y	N
6628-12718	54	138	31	6.19	34	47	41.194	138.518386	34.794776	-34.794776	PORT ADELAIDE	D55734	A303	CT 5973 985	SI5409	6628	3	30	r	4	Y	N	N	N	Y	N
6628-12719	54	138	31	6.19	34	47	41.194	138.518386	34.794776	-34.794776	PORT ADELAIDE	D55734	A303	CT 5973 985	SI5409	6628	3	30	r	4	Y	N	N	N	Y	N
6628-12720	54	138	31	6.19	34	47	41.194	138.518386	34.794776	-34.794776	PORT ADELAIDE	D55734	A303	CT 5973 985	SI5409	6628	3	30	r	4	N	N	N	N	Y	N
6628-12721	54	138	31	6.19	34	47	41.194	138.518386	34.794776	-34.794776	PORT ADELAIDE	D55734	A303	CT 5973 985	SI5409	6628	3	30	r	4	N	N	N	N	Y	N
6628-12722	54	138	31	6.19	34	47	41.194	138.518386	34.794776	-34.794776	PORT ADELAIDE	D55734	A303	CT 5973 985	SI5409	6628	3	30	r	4	Y	N	N	N	Y	N
6628-12723	54	138	31	6.19	34	47	41.194	138.518386	34.794776	-34.794776	PORT ADELAIDE	D55734	A303	CT 5973 985	SI5409	6628	3	30	r	4	N	N	N	N	Y	N
6628-12724	54	138	31	6.19	34	47	41.194	138.518386	34.794776	-34.794776	PORT ADELAIDE	D55734	A303	CT 5973 985	SI5409	6628	3	30	r	4	N	N	N	N	Y	N
6628-12725	54	138	31	6.19	34	47	41.194	138.518386	34.794776	-34.794776	PORT ADELAIDE	D55734	A303	CT 5973 985	SI5409	6628	3	30	r	4	Y	N	N	N	Y	N
6628-12726	54	138	31	6.19	34	47	41.194	138.518386	34.794776	-34.794776	PORT ADELAIDE	D55734	A303	CT 5973 985	SI5409	6628	3	30	r	4	N	N	N	N	Y	N
6628-12727	54	138	31	6.19	34	47	41.194	138.518386	34.794776	-34.794776	PORT ADELAIDE	D55734	A303	CT 5973 985	SI5409	6628	3	30	r	4	Y	N	N	N	Y	N
6628-12728	54	138	31	6.19	34	47	41.194	138.518386	34.794776	-34.794776	PORT ADELAIDE	D55734	A303	CT 5973 985	SI5409	6628	3	30	r	4	Y	N	N	N	Y	N
6628-12729	54	138	31	6.19	34	47	41.194	138.518386	34.794776	-34.794776	PORT ADELAIDE	D55734	A303	CT 5973 985	SI5409	6628	3	30	r	4	Y	N	N	N	Y	N
6628-12730	54	138	31	6.19	34	47	41.194	138.518386	34.794776	-34.794776	PORT ADELAIDE	D55734	A303	CT 5973 985	SI5409	6628	3	30	r	4	Y	N	N	N	Y	N
6628-12731	54	138	31	6.19	34	47	41.194	138.518386	34.794776	-34.794776	PORT ADELAIDE	D55734	A303	CT 5973 985	SI5409	6628	3	30	r	4	Y	N	N	N	Y	N
6628-12732	54	138	31	6.19	34	47	41.194	138.518386	34.794776	-34.794776	PORT ADELAIDE	D55734	A303	CT 5973 985	SI5409	6628	3	30	r	4	Y	N	N	N	Y	N
6628-12733	54	138	31	6.19	34	47	41.194	138.518386	34.794776	-34.794776	PORT ADELAIDE	D55734	A303	CT 5973 985	SI5409	6628	3	30	r	4	Y	N	N	N	Y	N
6628-12734	54	138	31	6.19	34	47	41.194	138.518386	34.794776	-34.794776	PORT ADELAIDE	D55734	A303	CT 5973 985	SI5409	6628	3	30	r	4	Y	N	N	N	Y	N
6628-12735	54	138	31	6.19	34	47	41.194	138.518386	34.794776	-34.794776	PORT ADELAIDE	D55734	A303	CT 5973 985	SI5409	6628	3	30	r	4	Y	N	N	N	Y	N
6628-12736	54	138	31	6.19	34	47	41.194	138.518386	34.794776	-34.794776	PORT ADELAIDE	D55734	A303	CT 5973 985	SI5409	6628	3	30	r	4	Y	N	N	N	Y	N
6628-12737	54	138	31	6.19	34	47	41.194	138.518386	34.794776	-34.794776	PORT ADELAIDE	D55734	A303	CT 5973 985	SI5409	6628	3	30	r	4	Y	N	N	N	Y	N
6628-12738	54	138	31	6.19	34	47	41.194	138.518386	34.794776	-34.794776	PORT ADELAIDE	D55734	A303	CT 5973 985	SI5409	6628	3	30	r	4	Y	N	N	N	Y	N
6628-12739	54	138	31	6.19	34	47	41.194	138.518386	34.794776	-34.794776	PORT ADELAIDE	D55734	A303	CT 5973 985	SI5409	6628	3	30	r	4	Y	N	N	N	Y	N
6628-12740	54	138	31	6.19	34	47	41.194	138.518386	34.794776	-34.794776	PORT ADELAIDE	D55734	A303	CT 5973 985	SI5409	6628	3	30	r	4	Y	N	N	N	Y	N
6628-12741	54	138	31	6.19	34	47	41.194	138.518386	34.794776	-34.794776	PORT ADELAIDE	D55734	A303	CT 5973 985	SI5409	6628	3	30	r	4	Y	N	N	N	Y	N
6628-12742	54	138	31	6.19	34	47	41.194	138.518386	34.794776	-34.794776	PORT ADELAIDE	D55734	A303	CT 5973 985	SI5409	6628	3	30	r	4	Y	N	N	N	Y	N
6628-12743	54	138	31	6.19	34	47	41.194	138.518386	34.794776	-34.794776	PORT ADELAIDE	D55734	A303	CT 5973 985	SI5409	6628	3	30	r	4	Y	N	N	N	Y	N
6628-12744	54	138	31	6.19	34	47	41.194	138.518386	34.794776	-34.794776	PORT ADELAIDE	D55734	A303	CT 5973 985	SI5409	6628	3	30	r	4	N	N	N	N	Y	N
6628-12745	54	138	31	6.19	34	47	41.194	138.518386	34.794776	-34.794776	PORT ADELAIDE	D55734	A303	CT 5973 985	SI5409	6628	3	30	r	4	Y	N	N	N	Y	N
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6628-12747	54	138	31	6.19	34	47	41.194	138.518386	34.794776	-34.794776	PORT ADELAIDE	D55734	A303	CT 5973 985	SI5409	6628	3	30	r	4	Y	N	N	N	Y	N
6628-12748	54	138	31	6.19	34	47	41.194	138.518386	34.794776	-34.794776	PORT ADELAIDE	D55734	A303	CT 5973 985	SI5409	6628	3	30	r	4	Y	N	N	N	Y	N
6628-12749	54	138	31	6.19	34	47	41.194	138.518386	34.794776	-34.794776	PORT ADELAIDE	D55734	A303	CT 5973 985	SI5409	6628	3	30	r	4	Y	N	N	N	Y	N
6628-12750	54	138	31	6.19	34	47	41.194	138.518386	34.794776	-34.794776	PORT ADELAIDE	D55734	A303	CT 5973 985	SI5409	6628	3	30	r	4	Y	N	N	N	Y	N
6628-12751	54	138	31	6.19	34	47	41.194	138.518386	34.794776	-34.794776	PORT ADELAIDE	D55734	A303	CT 5973 985	SI5409	6628	3	30	r	4	Y	N	N	N	Y	N
6628-12752	54	138	31	6.19	34	47	41.194	138.518386	34.794776	-34.794776	PORT ADELAIDE	D55734	A303	CT 5973 985	SI5409	6628	3	30	r	4	Y	N	N	N	Y	N
6628-12753	54	138	31	6.19	34	47	41.194	138.518386	34.794776	-34.794776	PORT ADELAIDE	D55734	A303	CT 5973 985	SI5409	6628	3	30	r	4	Y	N	N	N	Y	N
6628-12754	54	138	31	6.19	34	47	41.194	138.518386	34.794776	-34.794776	PORT ADELAIDE	D55734	A303	CT 5973 985	SI5409	6628	3	30	r	4	Y	N	N	N	Y	N
6628-12755	54	138	31	6.19	34	47	41.194	138.518386	34.794776	-34.794776	PORT ADELAIDE	D55734	A303	CT 5973 985	SI5409	6628	3	30	r	4	Y	N	N	N	Y	N
6628-12756	54	138	31	6.19	34	47	41.194	138.518386	34.794776	-34.794776	PORT ADELAIDE	D55734	A303	CT 5973 985	SI5409	6628	3	30	r	4	Y	N	N	N	Y	N
6628-12757	54	138	31	6.19	34	47	41.194	138.518386	34.794776	-34.794776	PORT ADELAIDE	D55734	A303	CT 5973 985	SI5409	6628	3	30	r	4	Y	N	N	N	Y	N
6628-12758	54	138	31	6.19	34	47	41.194	138.518386	34.794776	-34.794776	PORT ADELAIDE	D55734	A303	CT 5973 985	SI5409	6628	3	30	r	4	Y	N	N	N	Y	N
6628-12759	54	138	31	6.19	34	47	41.194	138.518386	34.794776	-34.794776	PORT ADELAIDE	D55734	A303	CT 5973 985	SI5409	6628	3	30	r	4	Y	N	N	N	Y	N
6628-12760	54	138	31	6.19	34	47	41.194	138.518386	34.794776	-34.794776	PORT ADELAIDE	D55734	A303	CT 5973 985	SI5409	6628	3	30	r	4	Y	N	N	N	Y	N
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6628-12762	54	138	31	6.19	34	47	41.194	138.518386	34.794776	-34.794776	PORT ADELAIDE	D55734	A303	CT 5973 985	SI5409	6628	3	30	r	4	Y	N	N	N	Y	N
6628-12763	54	138	31	6.19	34	47	41.194	138.518386	34.794776	-34.794776	PORT ADELAIDE	D55734	A303	CT 5973 985	SI5409	6628	3	30	r	4	Y	N	N	N	Y	N
6628-12764	54	138	31	6.19	34	47	41.194	138.518386	34.794776	-34.794776	PORT ADELAIDE	D55734	A303	CT 5973 985	SI5409	6628	3	30	r	4	Y	N	N	N	Y	N
6628-12765	54	138	31	6.19	34	47	41.194	138.518386	34.794776	-34.794776	PORT ADELAIDE	D55734	A303	CT 5973 985	SI5409	6628	3	30	r	4	Y	N	N	N	Y	N
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6628-12767	54	138	31	6.19	34	47	41.194	138.518386	34.794776	-34.794776	PORT ADELAIDE	D55734	A303	CT 5973 985	SI5409	6628	3	30	r	4	Y	N	N	N	Y	N
6628-12768	54	138	31	6.19	34	47	41.194	138.518386	34.794776	-34.794776	PORT ADELAIDE	D55734	A303	CT 5973 985	SI5409	6628	3	30	r	4	Y	N	N	N	Y	N
6628-12769	54	138	31	6.19	34	47	41.194	138.518386	34.794776	-34.794776	PORT ADELAIDE	D55734	A303	CT 5973 985	SI5409	6628	3	30	r	4	Y	N	N	N	Y	N
6628-12770	54	138	31	6.19	34	47	41.194	138.518386	34.794776	-34.794776	PORT ADELAIDE	D55734	A303	CT 5973 985	SI5409	6628	3	30	r	4	Y	N	N	N	Y	N
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6628-12774	54	138	31	6.19	34	47	41.194	138.518386	34.794776	-34.794776	PORT ADELAIDE	D55734	A303	CT 5973 985	SI5409	6628	3	30	r	4	Y	N	N	N	Y	N
6628-12775	54	138	31	6.19	34	47	41.194	138.518386	34.794776	-34.794776	PORT ADELAIDE	D55734	A303	CT 5973 985	SI5409	6628	3	30	r	4	Y	N	N	N	Y	N
6628-12776	54	138	31	6.19	34	47	41.194	138.518386	34.794776	-34.794776	PORT ADELAIDE	D55734	A303	CT 5973 985	SI5409	6628	3	30	r	4	Y	N	N	N	Y	N
6628-12777	54	138	31	6.19	34	47	41.194	138.518386	34.794776	-34.794776	PORT ADELAIDE	D55734	A303	CT 5973 985	SI5409	6628	3	30	r	4	N	N	N	N	Y	N
6628-12778	54	138	31	6.19	34	47	41.194	138.518386	34.794776	-34.794776	PORT ADELAIDE	D55734	A303	CT 5973 985	SI5409	6628	3	30	r	4	Y	N	N	N	Y	N
6628-12779	54	138	31	6.19	34	47	41.194	138.518386	34.794776	-34.794776	PORT ADELAIDE	D55734	A303	CT 5973 985	SI5409	6628	3	30	r	4	Y	N	N	N	Y	N
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6628-12781	54	138	31	6.19	34	47	41.194	138.518386	34.794776	-34.794776	PORT ADELAIDE	D55734	A303	CT 5973 985	SI5409	6628	3	30	r	4	Y	N	N	N	Y	N
6628-12782	54	138	31	6.19	34	47	41.194	138.518386	34.794776	-34.794776	PORT ADELAIDE	D55734	A303	CT 5973 985	SI5409	6628	3	30	r	4	Y	N	N	N	Y	N
6628-12783	54	138	31	6.19	34	47	41.194	138.518386	34.794776	-34.794776	PORT ADELAIDE	D55734	A303	CT 5973 985	SI5409	6628	3	30	r	4	Y	N	N	N	Y	N
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6628-12785	54	138	31	6.19	34	47	41.194	138.518386	34.794776	-34.794776	PORT ADELAIDE	D55734	A303	CT 5973 985	SI5409	6628	3	30	r	4	Y	N	N	N	Y	N
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6628-12787	54	138	31	6.19	34	47	41.194	138.518386	34.794776	-34.794776	PORT ADELAIDE	D55734	A303	CT 5973 985	SI5409	6628	3	30	r	4	Y	N	N	N	Y	N
6628-12788	54	138	31	6.19	34	47	41.194	138.518386	34.794776	-34.794776	PORT ADELAIDE	D55734	A303	CT 5973 985	SI5409	6628	3	30	r	4	Y	N	N	N	Y	N
6628-12789	54	138	31	6.19	34	47	41.194	138.518386	34.794776	-34.794776	PORT ADELAIDE	D55734	A303	CT 5973 985	SI5409	6628	3	30	r	4	Y	N	N	N	Y	N
6628-12790	54	138	31	6.19	34	47	41.194	138.518386	34.794776	-34.794776	PORT ADELAIDE	D55734	A303	CT 5973 985	SI5409	6628	3	30	r	4	Y	N	N	N	Y	N
6628-12791	54	138	31	6.19	34	47	41.194	138.518386	34.794776	-34.794776	PORT ADELAIDE	D55734	A303	CT 5973 985	SI5409	6628	3	30	r	4	Y	N	N	N	Y	N
6628-14448	54	138	30	43.382	34	48	26.717	138.51205	34.807421	-34.807421	PORT ADELAIDE	D41578	A7	CT 5655 247	SI5409	6628	3	31	a	5	N	N	N	N	N	N
6628-20472	54	138	31	21.299	34	48	22.68	138.522583	34.8063	-34.8063	PORT ADELAIDE	D55734	Q301	CT 5973 985	SI5409	6628	3	31	a	4	Y	Y	N	N	Y	Y

Appendix L

Cultural heritage survey preliminary advice

ACHM
AUSTRALIAN CULTURAL HERITAGE MANAGEMENT

Scott L'Oste-Brown
Central Queensland Cultural Heritage Management
16 Moren Street
North Rockhampton QLD 4701

22/12/2009

Dear Scott,

Re: AGL Torrens Island Cultural Heritage Survey – Current Status and Preliminary Advice

Due to time constraints ACHM are unable to provide a cultural heritage report for the partially surveyed proposed AGL plant expansion footprint. This letter provides details of current status including the future proposed survey and reporting works and some preliminary advice.

Current Status

Currently about 60% of the proposed AGL plant expansion footprint survey area has been covered by archaeological survey. Anthropological survey has resulted in 100% coverage. The first phase of the Aboriginal cultural heritage survey was conducted on Wednesday 9 December 2010. Survey participants are listed in Appendix.

As discussed it is anticipated that the remainder of the survey area can be subject to archaeological survey in early 2010. See the attached map for the delineations of the surveyed and non-surveyed areas.

Desktop research and access to site cards delineating previously recorded sites has not been possible within the tight timeframe.

Preliminary Advice

Anthropology

The anthropological survey discussed a number of topics relating to specific ethnographic information for Torrens Island. This relates to Emu Dreaming, Seven Sisters and Tjilbruke Dreaming. Black Swan story was also mentioned. No specific anthropological site was delineated for the project footprint and it is not possible to detail the stories here – this is because there has not been sufficient time to ratify the information via Kaurna Nation Cultural Heritage Association (KNCHA) and to divulge Aboriginal sites information without ratification from the appropriate Traditional Owner representatives (i.e. KNCHA) would be a potential breach of Section 35 of the SA *Aboriginal Heritage Act 1988*.

• **Adelaide** • PO Box 451, Hindmarsh, SA 5007 • **P** : (08) 8340 9566 • **F** : (08) 8340 9577 • **W** : www.achm.com.au • **E** : email@achm.com.au
• **Perth** • PO Box 2031, Warwick, WA, 6024 • **P** : (08) 9247 1217 • **F** : (08) 9247 1217 • **W** : www.achm.com.au • **E** : email@achm.com.au
• **Melbourne** • GPO Box 5112, Melbourne, VIC 3000 • **P** : 1300 724 913 • **F** : (03) 5781 0860 • **W** : www.achm.com.au • **E** : email@achm.com.au

Archaeology

The archaeological survey covered approximately 60% of the proposed AGL plant expansion footprint and did not record any artefacts. This was not unexpected considering the relatively high level of physical disturbance for the general area. It is prudent to discuss the potential for archaeological deposits in reference to what little information we have been able to research in the short time afforded.

Six Aboriginal sites are entered on the AARD Central Archive in proximity to the general project area (Table 1). An opportunity to relocate and assess these has not occurred to date. The nearest archaeological site is reportedly located approximately 45 metres from the western edge of the proposed expansion footprint. The rest are reportedly located at least another 180 metres to the northwest and beyond. The current project areas do not intersect with these locations.

AARD Site Number	AARD Site Name	AARD Site Type	Easting (GDA94)	Northing (GDA94)
8069	Torrens Island Artefact Site 1	Artefact Scatter	272815	6146215
8071	Torrens Island Artefact Site 2	Artefact Scatter	272817	6146376
8073	Torrens Island Artefact Site 3	Artefact Scatter	272724	6146567
8075	Torrens Island Artefact Site 4	Artefact Scatter	272857	6146601
8077	Torrens Island Artefact Site 5	Artefact Scatter	272900	6146652
8081	Torrens Island Artefact Site 7	Artefact Scatter	272918	6146132

Table 1 Aboriginal sites on the AARD Central Archive

The South Australian Museum Anthropology Database details the contents of human remains and cultural items held by the South Australian Museum. An initial search of the database returned 3 results held by the museum with location details matching the general project area (Table 2). A more comprehensive search will be done for the main report. Again time constraints for this reporting means that background information discussed in this section is by no means exhaustive.

Registry Number	Description	Region	Locality
A38864	Skull, and skeleton, part of	Adelaide	S. A., Torrens Island
A11510	Skull with jaw and part skeleton	Adelaide	Torrens Island
A11528	Skull and jaw	Adelaide	Torrens Island

Table 2 Details of Aboriginal items held by the South Australian Museum with provenance associated to the project area

The location details of items held by the museum are general and as such, are best applied as an indicative tool. The South Australian Museum database provides can assist to provide a notional baseline to establish whether subsurface archaeological deposits, including burials, may be uncovered during excavations.

During the survey a number of comments were received and observations made that are relevant when examining the potential for archaeological deposits.

Joe Mitchell was told by his mother as a boy never to go near Torrens Island. He thinks this has something to do with the fact that the island was used by Kaurna as a burial ground. When Joe used to go cockling with his Mum when he was a boy, she said of Torrens Island, ‘Don’t go over to that island.’ Port Adelaide is called the Land of Sleep/Death.

Kaurna people used to camp along the river from Pelican Point up to Port Adelaide (pers. comm. Joe Mitchell). Joe also observed that the Port River used to be only an estuary – not a wide river like it is now. You used to be able to walk across to the island.

Aside from these comments in the field, an archaeological examination of the landscape takes into account the previously recorded archaeological records in proximity. One can reasonably infer that the presence of artefact sites nearby is indicative of Aboriginal occupation for the general area that may well have extended into the current survey area. The presence of soft, sandy soils throughout and the currently unknown level of subsurface disturbance mean that it is prudent to assume a moderate level of risk in relation to subsurface undisturbed soils. The presence of disturbed artefacts is also of moderate risk in the project area.

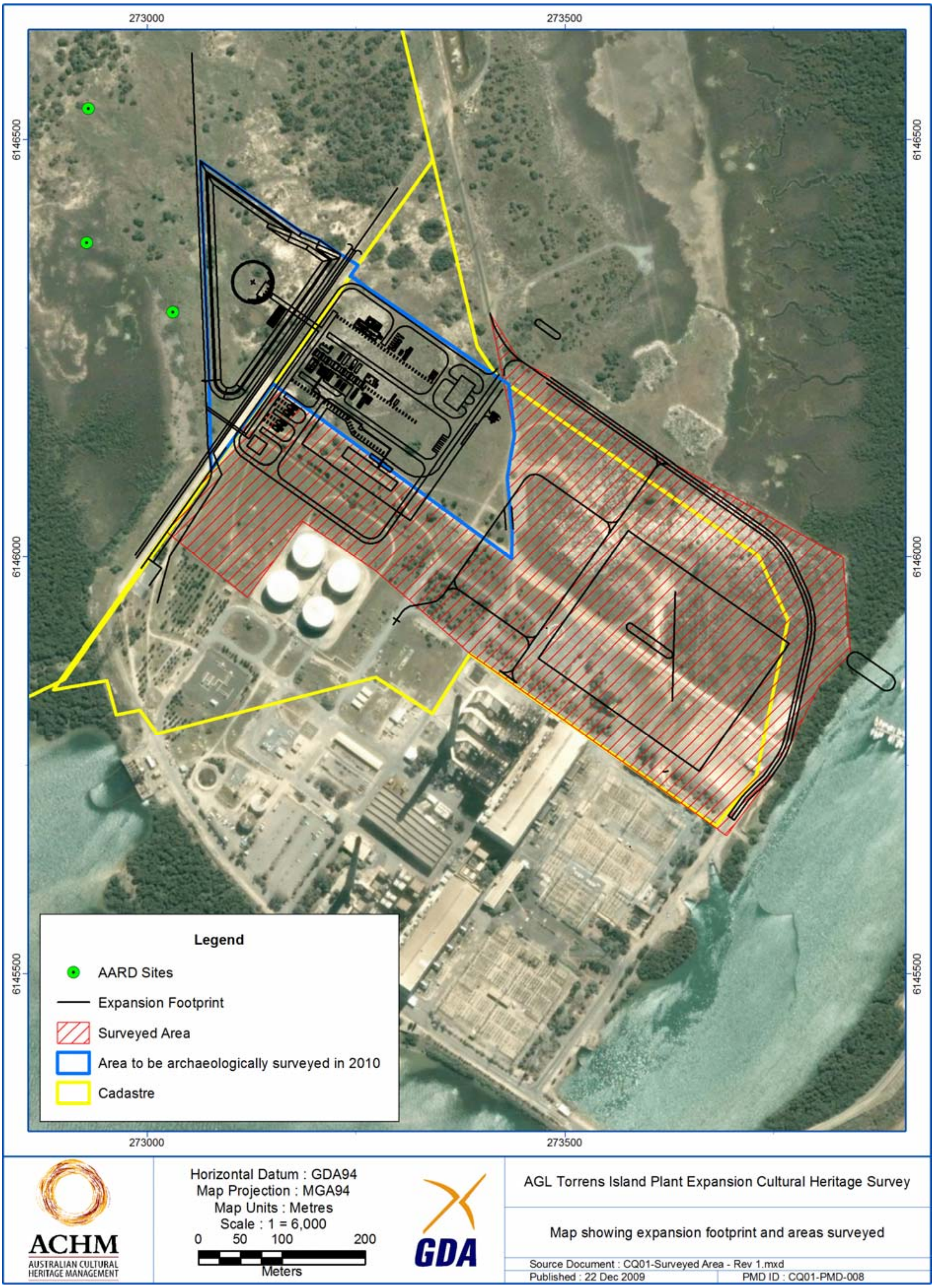
Summary

The initial survey has found that the specific survey area is of significance to Kaurna. Whilst no archaeology was recorded on the surface there exists a medium potential for subsurface archaeological deposits to be found in the project area, particularly where soils are being disturbed for the first time.

KNCHA and ACHM need more time to conduct adequate background research and to access site cards delineating and describing previously recorded sites. Further survey work also needs to be conducted on the area delineated on the attached map. Once this work is able to be completed a full report can be submitted detailing all known information and specific recommendations for the certainty of the client and KNCHA.

Yours sincerely

David Mott
Senior Archaeologist
ACHM


273000
273500
6146500
6146000
6145500
Legend
AARD Sites
Expansion Footprint
Surveyed Area
Area to be archaeologically surveyed in 2010
Cadastre
ACHM
AUSTRALIAN CULTURAL HERITAGE MANAGEMENT
Horizontal Datum : GDA94
Map Projection : MGA94
Map Units : Metres
Scale : 1 = 6,000
0 50 100 200
Meters
GDA
AGL Torrens Island Plant Expansion Cultural Heritage Survey
Map showing expansion footprint and areas surveyed
Source Document : CQ01-Surveyed Area - Rev 1.mxd
Published : 22 Dec 2009
PMD ID : CQ01-PMD-008

Appendix

KNCHA:
Trevor Wanganeen
Glenice Sumner
Frank Wanganeen
Betty Sumner
Jeffrey Newchurch
Shane Wanganeen
Crystal Sumner
Gordon Wanganeen
Madge Wanganeen
Joe Mitchell (consultation meeting at ACHM Port Road only)

ACHM:
Dennis O'Brien (Anthropology)
Nadia Butler (Anthropology)
Stephen Damhuis (Archaeology)

AGL:
Brian Hollingworth

Central Queensland Cultural Heritage Management:
Scott L'Oste-Brown

Project Dolphin Safe and SA Seabird Rescue
Aaron Machado

Appendix M

Non-Indigenous historical and cultural heritage study

AUSTRAL ARCHAEOLOGY

Torrens Island Energy Park
Non-Indigenous Historical And Cultural Heritage Study

Prepared for
Coffey Natural Systems
on behalf of AGL Energy Limited
Adelaide SA

7 December 2009

Adelaide: GPO BOX 2301 ADELAIDE SOUTH AUSTRALIA 5001 TELEPHONE 08 8331 9037 FAX 08 8364 2722
Sydney: SHOP 1, 92 PERCIVAL ROAD STANMORE NEW SOUTH WALES 2048 TELEPHONE 02 9568 6701 FAX 02 9568 6702
www.australarchaeology.com.au Certified Quality System to AS/NZS ISO9001:2008
Austral Archaeology Pty Ltd ABN 25 008 174 829

CONTENTS

Page

1.0 INTRODUCTION

1.1 Background

Austral Archaeology Pty Ltd has been commissioned by Coffey Natural Systems to undertake a non-indigenous historical and cultural heritage study of a proposed Energy Park at the Torrens Island Power Station.

AGL Energy Limited (AGL) has engaged Coffey Natural Systems to assist in environmental and social permitting for the project. The proposed Energy Park at Torrens Island would play a critical role in securing South Australia's future energy supplies. The project is estimated to require a capital expenditure in excess of $800 million.

AGL currently proposes the Energy Park to consist of the following components:

- Liquefied natural gas (LNG) production plant, storage tank and re-gasification units – known as a gas storage facility.
- Power station expansion (gas turbine peaking plant).

Some of these components may vary according to future needs.

AGL intends for the project to be permitted as a Crown Development or Public Infrastructure under Section 49 of the Development Act 1993. An environmental and social impact assessment (ESIA) is not a set requirement of approvals under this section of the Act. However, AGL considers an environmental and social assessment will assist the Development Assessment Commission (DAC), the public and the Minister in understanding the potential impacts of the project and in making an informed decision regarding its approval. Therefore AGL intends to submit an Environmental and Social Assessment Report (ESAR) along with the development application for the project.

The non-indigenous historical and cultural heritage study comprises one of the specialist studies required to assess potential impacts of the project as part of the project ESAR.

1.2 Project Description

AGL Energy Limited (AGL) is the owner and operator of the Torrens Island Power Station (TIPS). The power station was constructed between 1963 and 1981 and was purchased by AGL in July 2007. TIPS currently comprises 8 natural gas fired steam cycle units, i.e. boilers and steam turbines, with a total generating capacity of 1,280 MW of electricity. The power station is fuelled with natural gas supplied via the SEAGas pipeline from Victoria and via the Moomba to Adelaide pipeline (MAP).

AGL proposes to expand its existing facilities at the TIPS site to create an Energy Park that will allow for progressive development of a series of energy based projects. The proposed components of the Energy Park are described in the following sections.

Gas Storage Facility

The gas storage facility would receive natural gas from a pipeline (either SEAGas or MAP), cool and liquefy the gas and store it in a cryogenic tank on site for use when required. The LNG tank would be approximately 35 m in diameter and 50 m high.

The stored LNG may be used in the following ways:

- Electricity generation – vaporise LNG and transfer to TIPS during peak demand.
- Gas supply – vaporise LNG and transfer natural gas to the pipeline network for sale in SA.
- Security of supply – vaporise LNG for either power generation or transfer to the SA gas distribution network in time of supply disruption.
- LNG supply – transfer to road tanker for sale to market as an alternative, lower carbon intensity fuel for heavy duty trucks or remote power generation.

Power Station Expansion
The future expansion of TIPS may be in the form of new open cycle or combined cycle gas turbines in addition to the existing power station. The total expanded capacity could be in the order of 1,800 MW, of which 480 to 900 MW would be new.

The final mix and type of new installed capacity is still to be determined and a number of options are being evaluated including peaking generation of:

- Up to four (4) "E" class gas turbines with a nominal capacity of between 120MW and 190MW each or:
- two (2) "F" class gas turbines with a nominal capacity of between 200MW and 300MW each.

The gas turbines would be operated in open cycle configuration.

This infrastructure is to be constructed on land that is currently vacant and appears to have no non-indigenous heritage or cultural significance. The non-indigenous historical and cultural survey has been commissioned to determine whether the specific land parcels to be utilised have any inherent heritage values or archaeological potential.

1.3 Study Area

The Energy Park will be located adjacent to the existing TIPS on Torrens Island, 15 km northwest of Adelaide, South Australia. Torrens Island is connected to the mainland by the Grand Trunkway Bridge over the North Arm to Garden Island and a causeway between Garden and Torrens Islands. Torrens Island is zoned as Public Purpose (Power Station) under the *Land Not Within A Council Area (Metropolitan) Development Plan 2009*.

The proposed location of the Energy Park is shown in Figure 1. The study area includes all areas that may be affected by the proposed Energy Park.

The proposed site of the Energy Park project is located in proximity to the following features:

- Torrens Island Conservation Park.
- Garden Island.
- Waterways that include Angas and Barker Inlets, the North Arm and Port River.
- The Small Boat Club in Angas Inlet.
- North Arm shipyards.
- Port side lands and berths as well as the industrial area, which lies between the Port River and the residential areas on the LeFevre Peninsula.

1.4 Objectives

The objectives of the non-indigenous historical and cultural heritage study as defined in the brief are to:

- Provide baseline information on non-indigenous sites of historical and cultural heritage significance and identify areas of known and potential sensitivity in relation to such sites within the project area.
- Recommend measures for mitigating and monitoring potential impacts.

Please note that:

- this study is confined to historic heritage issues. A study relating to native title and the presence of sites of Indigenous archaeological and anthropological significance in the project area has been commissioned by AGL separately.
- assessment of natural heritage values is not within the scope of this report.

1.5 Methods

The following methods were employed in carrying out this study.

- **A search of statutory and non-statutory heritage registers** for known non-indigenous historical archaeological and heritage sites located in the immediate vicinity was conducted;
- **Background research** was undertaken. This involved historical research as a well as a review of heritage assessments of sites in the area and of sites of similar type;
- **Liaison** with Coffey Natural Systems was undertaken to obtain relevant mapping and any other available background material;
- **A field inspection** was undertaken to confirm and clarify the results of the desktop study;
- **A synthesis of the results** of the heritage register searches, background literature, historical research and site inspection have been undertaken as part of the report;
- **An assessment of the significance** of identified sites has been undertaken. This assessment informs the management and mitigation recommendations presented at the end of this report;
- **Management and mitigation recommendations** that respond to the assessed level of significance have been prepared.

1.6 Authorship

This report has been prepared by Justin McCarthy (Managing Director, Austral Archaeology Pty Ltd). Dr Peter Bell of Historical Research Pty Ltd undertook the historical background research and prepared Section 2.0.

1.7 Acknowledgements

The assistance of the following people is gratefully acknowledged:

Rychard Oleszczyk	AGL, Torrens Island Power Station
Gabriella Szondy	AGL, Torrens Island Power Station
Joanne Lee	Coffey Natural Systems

1.8 Limitations of the Report

The results, assessments and judgements contained in this report are constrained by the limitations of historical research and by the unpredictability inherent in archaeological assessment. Whilst every effort has been made to gain insight to the historical archaeological profile of the subject site, Austral Archaeology Pty Ltd cannot be held accountable for errors or omissions arising from such constraining factors.

Figure 1 Study Area and Location Plan. (Source: Coffey Natural Systems)

2.0 HISTORICAL BACKGROUND

2.1 The Setting

The Port River is an old mouth of the Torrens, formed in a wetter climate when the river had much more energy than it has today. Its mouth was pushed north by the wave action of the gulf waters and the north-flowing coastal current along the beaches. The northward drift of sand along the shore forced the Torrens channel further and further north to flow behind the foreshore dunes as Lefevre Peninsula steadily built a growing barrier between the river and the sea. The Torrens formed its northern-most mouth to the sea through the estuary of Barker Inlet, building up a delta of islands and shoals where it met the waters of the gulf. But as its flow diminished in recent times it rarely had the energy to flow beyond the wetlands of the Reedbeds, and the old northern mouth became a maze of abandoned tidal channels. (Belperio 1993)

The largest island of the delta is Torrens Island, a teardrop-shaped shoal about 6km from north to south. Its highest land is the sand dunes of the western coast, which form the east bank of the Port River for about 5km. The south shore of the island is formed by the North Arm, which connects the Port River with Barker Inlet. The largest vegetation today is a fringe of stunted acacia and callitris trees growing on the western dunes, but among them there are remnant stumps of larger trees, suggesting that there was once mature woodland. East from these dunes, most of the land is in the inter-tidal zone with samphire flats inland and grey mangroves (*Avicennia marina)* growing along the river channels. In the south-east, a channel called Angas Inlet separates Torrens Island from the smaller Garden Island.

2.2 Summary

Since European settlement in 1836, there have been a number of episodes of activity on Torrens Island more or less continuously to the present. These include:

- a dairy farm
- two human quarantine stations
- three animal quarantine stations
- two internment camps
- two electricity generating stations.

All of these activities have been located along the dune formation forming the western side of the island. Several of them have succeeded each other on the same site on the highest dunes at the southern end of the island, overlooking the North Arm.

2.3 Heritage Listings

A search of statutory and non-statutory heritage registers for known non-indigenous historical archaeological and heritage sites and places located in the immediate vicinity was undertaken.

Two sites are listed:

- **Torrens Island Quarantine Station.** It is listed on the State Heritage Register (No 13931) and on the Register of the National Estate as an Indicative Historic Place (No 14866). See Figure 2 for a delineation of the site curtilage.
- **Torrens Island Conservation Park.** It is listed on the Register of the National Estate as a Registered Natural Place (No 6255). The extreme northern tip of the area was declared a Conservation Park in the Schedule to the SA *National Parks and Wildlife Act* 1972. The boundaries of the park were extended southward to take in the rest of the inter-tidal zone in 2005, so that it now covers most of the island except for the dune formation along the western shore.

Figure 2 Plan showing the curtilage of the Quarantine Station as entered in the SA Heritage Register (Source: SA Heritage Branch)

2.4 History of Torrens Island

The first European settlers arrived in South Australia by sea, and the new colony had to begin with the establishment of a harbour and the site for a city. The discovery by William Light of the entrance to the Port River in September 1836 fixed the location of the capital and set in train the process of settlement. From 1837 to the present, Port Adelaide has been South Australia's principal harbour, although the focus of shipping has shifted steadily downstream from the Old Port (now West Lakes) to the New Port in the 1840s, to Ocean Steamers Wharf in the 1880s and to Outer Harbor since 1908. Torrens Island, forming the east bank of the Port River for 5km, has thus been alongside a busy shipping channel for 172 years, and has seen much activity, although its low-lying saline environment and lack of fresh water has limited its potential for development.

2.4.1 Maritime Activities

From the beginning of European settlement, people have visited Torrens Island to engage in activities such as recreational and commercial fishing, crabbing in the wetlands, rabbit trapping, and firewood cutting in the woodland along the western shore. There are reports of people camping on Torrens Island to gather flotsam - floating items of cargo and ship's equipment - lost overboard and carried down the river from the port by the outgoing tide. While activities such as these undoubtedly took place over a long time, they did not involve construction of infrastructure, and are unlikely to have left much evidence in the archaeological record.

2.4.2 Early Farming

The earliest recorded permanent resident of Torrens Island was Isaac Yeo, who established a dairy farm on the western shore at some time after he arrived in the colony in 1847. Why he thought Torrens Island looked like a promising place for dairy farming is a mystery. He and others were certainly settled there in 1859 when a newspaper gave a brief description of their houses, built of limestone dredged from a rock bar in the river channel. (*Advertiser* 19 February 1859) Yeo's land was towards the northern end of the island, and included the later site of the Quarantine Station. At the time the only access to the island was by small boat, and Yeo's son drowned in a night-time boat capsize while crossing the Port River. The South Australian government bought Yeo's farm to establish a quarantine station in 1875, and compulsorily acquired all other private land on the island in 1882. (*Register* 28 July 1891; McDougall & Vines 1988, pp. 11-12)

2.4.3 Torrens Island Quarantine Station

Early cases of passengers needing to be quarantined at Port Adelaide were dealt with by simply requiring the arriving ship to remain at anchor in the gulf until granted pratique. There were moves to establish a shore station on Torrens Island in the 1850s, but it is uncertain exactly what was built or where it was located. In 1856 a timber-framed dormitory and kitchen, wash-house and fumigation room were said to have been built at a cost of £726. In 1859 the quarantine station was described as tents and a "decent-looking stone building, near to the water's edge". (*Advertiser* 19 February 1859) One description of the site put it "a mile and a half south" of the later site of the 1870s quarantine station, which would place it about half way up the western side of the island, near the present Osborne Gas Regulator Station. (McDougall & Vines 1988, pp. 9-11; *Observer* 1 February 1879) However, the evidence of a 1916 Court of Enquiry refers to: "the southern end of the island, near an old quarantine station which had been unused for many years." (NAA Series MP367/1 Item 567/3/2202) Wherever it was, this early station was apparently abandoned or unsuitable within twenty years, for by the early 1870s, quarantined passengers were being confined on a moored hulk off Semaphore. (McDougall & Vines 1988, p. 11) There seems to be no trace of the 1850s quarantine station discernible today.

The government took more definite action in the 1870s. Isaac Yeo's farm was acquired in 1875, but a quarantine crisis at the port in 1877 prompted new quarantine regulations and a decisive move to build a permanent quarantine facility. It was completed by early 1879, in an iron-fenced enclosure on the western shore with a jetty, dormitories for single passengers, cottages for married couples, hospital wards, disinfecting rooms, a doctor's residence, staff quarters, kitchens, dining rooms and a mortuary. Some of the buildings were prefabricated houses imported from San Francisco. The total cost was £25,000. (*Observer* 1 February 1879)

Figure 3 Quarantine Station timber barracks as completed in 1879. (Source: SLSA B4071. Image courtesy of the State Library of South Australia.)

The Torrens Island Quarantine Station would function for nearly a hundred years. But the reality of managing a quarantine station was that the arrival of a vessel with infectious disease aboard would bring a crisis of intense activity typically lasting a few days, or at most weeks. This might be followed by long periods in which nothing happened, possibly for years. Yet between crises the buildings and stores at the station had to be maintained in readiness to receive hundreds of passengers at short notice. By 1896 four people had died at the quarantine station, and the cemetery where they were buried at the north end of the island was consecrated in a religious ceremony. (*Register* 15 June 1896)

In 1909 the station was taken over by the Commonwealth Quarantine Service under the provisions of the Federal *Quarantine Act* 1908. In the years from 1912 to 1915 this brought a new round of building activity, as the station was brought up to the standards of Commonwealth quarantine stations at all the major Australian ports. A boiler house and autoclave disinfecting room were added, along with other buildings. One of the worst crises at the quarantine station occurred in 1918, when the troopship *Boonah* returned from South Africa with Australian soldiers suffering from Spanish Influenza, and the passengers and crew were quarantined at Torrens Island. Five soldiers died at Torrens Island and are buried in the cemetery. (McDougall & Vines 1988, p. 19)

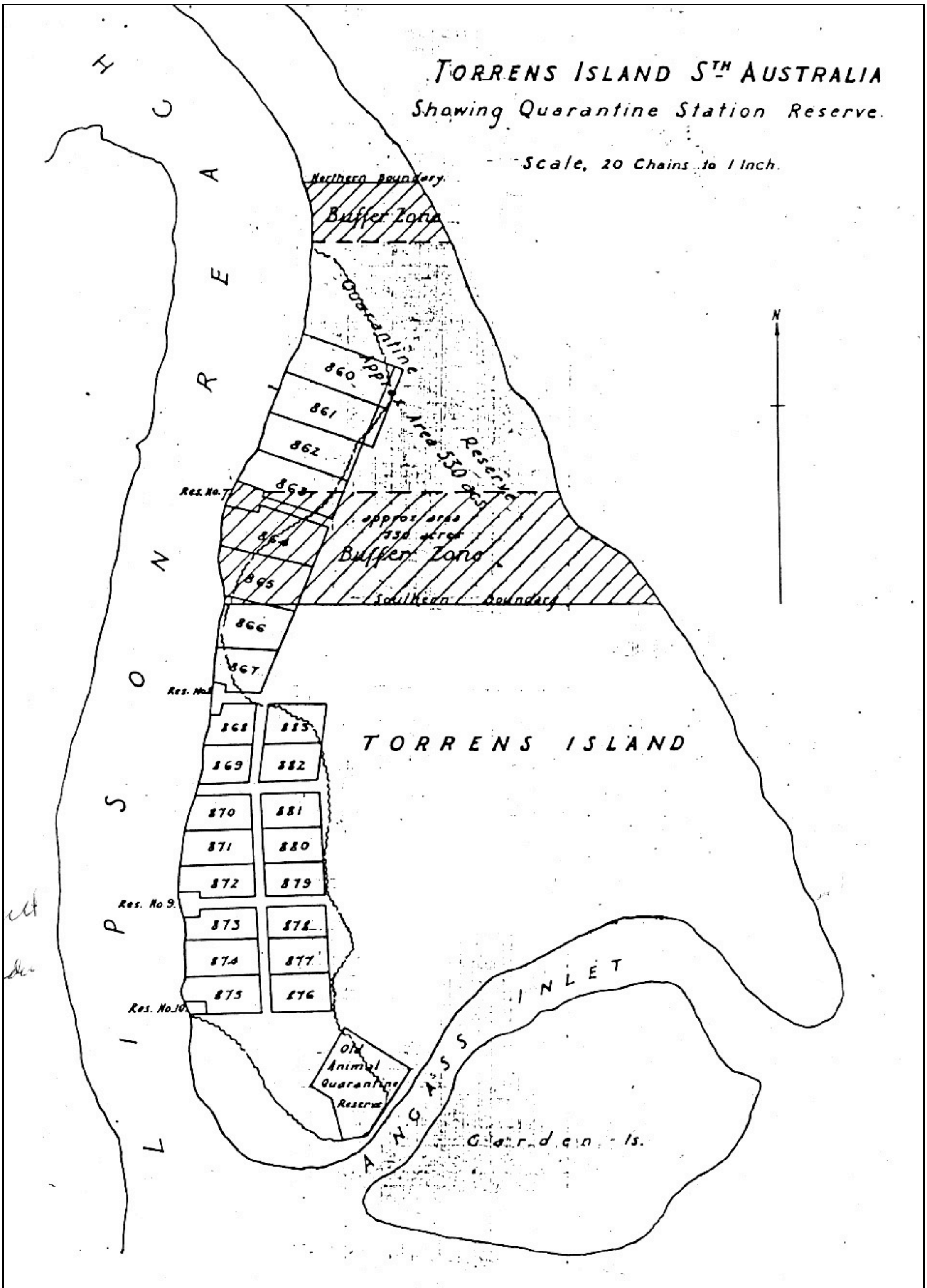


Figure 4 Land subdivision on Torrens Island, 1909 (Source: McDougall & Vines 1988, p. 10)

In 1921 a separate timber ward for isolating patients with venereal diseases was built a few hundred metres south of the main quarantine station. The Venereal Diseases Hospital was also used as a general isolation unit, and operated only sporadically, usually in times of war, until 1970. The buildings were demolished about 1999 when a power station was built on the site (this is not the AGL owned power station for which an expansion is proposed).

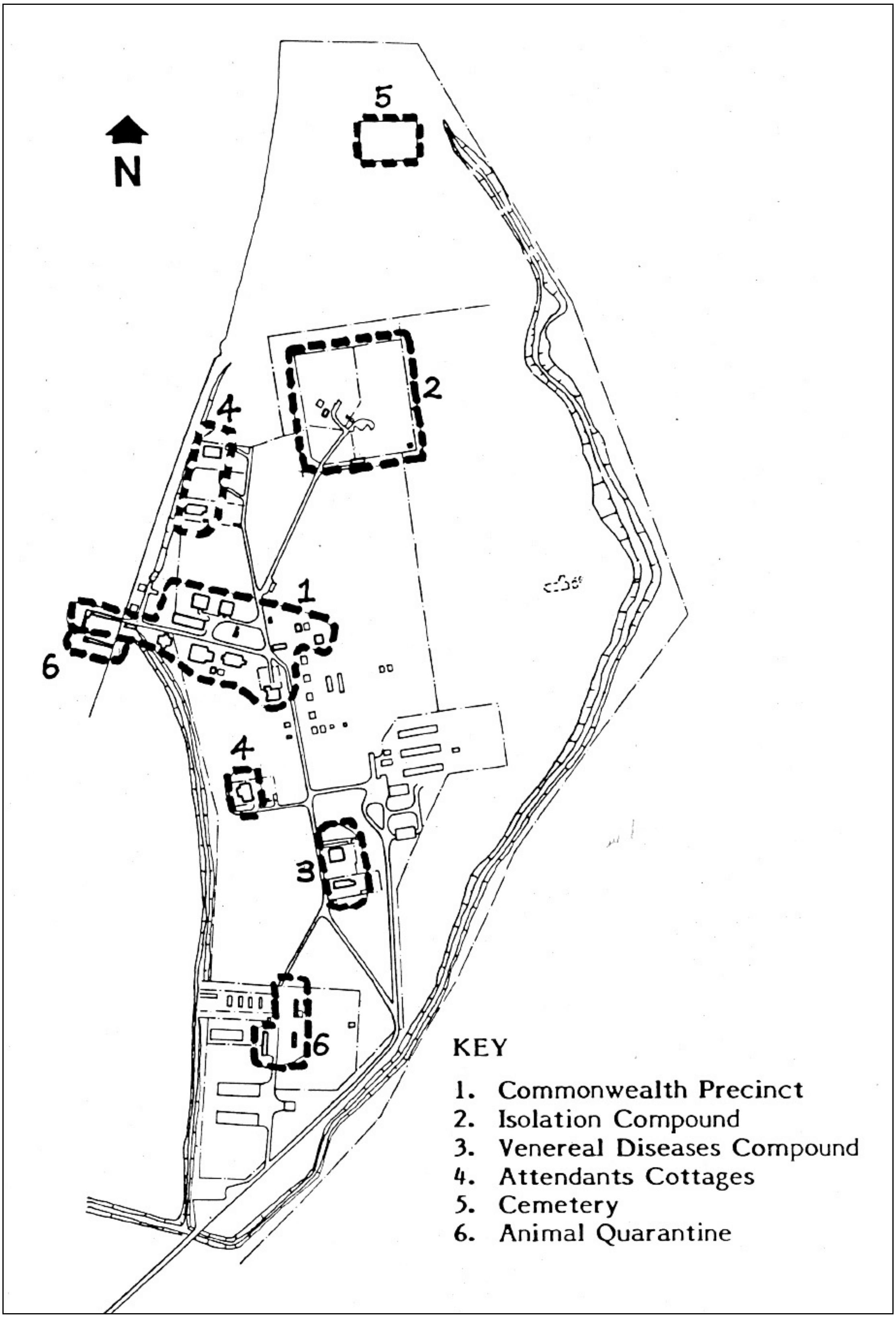


Figure 5 Buildings of Torrens Island Quarantine Station, 1988. (Source: McDougall & Vines 1988, p. 5)

By the 1960s, quarantine stations all over Australia were falling into disuse, and Torrens Island admitted its last passengers in 1966. Infectious diseases were being treated at purpose-built modern hospitals, and international air travel was making the control of ship-borne diseases irrelevant. The last disease of concern to the Quarantine Service was smallpox, which was declared extinct in 1979. The Torrens Island Quarantine Station was formally closed in 1980, and most of its buildings were auctioned and removed. Some of the remaining buildings were entered in the SA Heritage Register in 1993.

2.4.4 Animal Quarantine

The history of animal quarantine on Torrens Island is even longer than that of human quarantine, for the island has been used to quarantine animals continuously from 1879 to the present day. Not surprisingly, the early history of animal quarantine in South Australia closely parallels that of human quarantine. In early 1879 the Adelaide newspapers reported on the new Stock Quarantine Station:

> The intended removal of the prohibition on the importation of stock from Europe has induced the government to fix upon the extreme southern end of Torrens Island as the site for a stock quarantine ground, and tenders will shortly be called for the erection of necessary works in connection therewith. These comprise a small cottage for the use of the person who will be in charge, sheep-dipping places, and six cattle pens.... Wells have already been sunk, and an area of twenty-five acres will be fenced in. (*Register* 22 April 1879)

The site is shown on a 1909 survey map of Torrens Island, on the high dune at the southern end, overlooking Angas Inlet. This remained the animal quarantine area until the Commonwealth took over in 1909. They built new buildings including a cottage, horse stables and storerooms further north, not far from the human quarantine station. Some of these buildings still stand, incongruously located at the entrance to the Quarantine Power Station.

Although the early buildings and facilities have been allowed to run down, some form of animal quarantine has continued to the present. The animal quarantine paddocks officially closed in 1995. But a smaller Avian Quarantine Facility had opened in 1989. It is still operated by the Australian Quarantine and Inspection Service, principally to provide quarantine for commercial poultry which are imported as fertilised eggs and hatched in a quarantined aviary.

2.4.5 Torpedo Station

With the withdrawal of British regiments and warships from Australia in the 1870s, the various colonies began to organise their own defences. In 1877 work commenced on coastal defences to protect the Port River from naval raiders. By 1885 three installations had been completed, consisting principally of Fort Largs and Fort Glanville, whose guns commanded the gulf approaches. Less well known is the Torpedo Station, which sat in the south-east angle of the Port River and the North Arm, just south of the southern tip of Torrens Island. The station was the last defence against a warship which had entered the river. At first it was equipped with a cable boom to block the shipping channel, underwater mines and a single 6-inch gun. Later, in 1905 the station was equipped with a light Thorneycroft torpedo boat dating from 1884, which normally sat on a slip on the river bank. The Torpedo Station was always a forlorn defensive measure, and the events of the First World War demonstrated that it could make no useful contribution to modern naval warfare. By 1917 all the buildings on the site had been demolished or removed to the Port Adelaide depot. (Wimmer 2005)

2.4.6 Internment Camp

The South Australian population included a large minority of German descent, who for generations had been universally described as devout, thrifty, sober and hard-working citizens. However, the outbreak of the First World War in 1914 brought a wave of anti-

German feeling. People with German names were harassed in the streets or sent threatening letters, and their businesses were boycotted.

At an official level, the *War Precautions Act* permitted sweeping powers of search, seizure of property and arrest. Lutheran churches and schools were closed and German language newspapers were banned. In August 1914 soldiers were sent out under the authority of the Act to round up about 300 “Germans”. At first they were interned in a barbed wire compound at Keswick Barracks, then in October they were taken by boat to Torrens Island. A fenced compound was built about 500m south of the Quarantine Station, and the prisoners were interned there in tents under armed guard. At the time it was officially called a Concentration Camp. The internees included some German citizens and some Australian born, a mixture of farmers, intellectuals and Lutheran pastors; they were only a small fraction of the people of German descent in South Australia, and among them the authorities had managed to round up some citizens of Sweden, the Netherlands and one from the USA, all neutral countries.

In its first few months the Torrens Island internment camp was uncomfortable, but not harsh. The internees put on amateur dramatic performances and published their own newsletter. In early 1915 a new commanding officer, Captain Hawkes, was posted to the camp, and in about March 1915 the camp was shifted to another location further south away from the Quarantine Station, on the southern end of Torrens Island, at or near the original site of the animal quarantine ground.

Captain Hawkes was to prove extremely unsuitable for the position, and under his command treatment of the internees deteriorated. He encouraged an atmosphere in which guards became routinely offensive and violent in their behaviour, and soon afterward stories of brutal treatment began to be circulated. Subsequent enquiries found evidence of prisoners being punished for disciplinary offences by exposing them to the weather in an open barbed wire compound, prisoners habitually being prodded with bayonets, and illegal punishments in which internees were stripped, handcuffed and publicly flogged. One of these incidents involved a Swedish and an American citizen. There were also rumours of worse brutalities, and prisoners being shot dead by guards, but the facts about Torrens Island are difficult to verify. Certainly on one occasion Captain Hawkes had fired his pistol into a tent full of internees, wounding one. Probably flogging the American was his worst mistake. The prisoner wrote to the US Consul about conditions in the camp, forcing an enquiry in June 1915 which brought conditions into the open.

The camp was quietly closed in August 1915, some of the internees were released, and others were transferred to a more humanely-run camp at Holsworthy in New South Wales. Captain Hawkes was dismissed from the service, and in 1916 a Court of Enquiry was held into his conduct. None of this became public knowledge until after the war, when in 1919 the Adelaide press published the headlines, "Torrens Island Revelations". (*Mail* 17 May 1919) The official records of the camp were destroyed, and to this day, almost everything we know about the incident comes from the only wartime records that survive, principally the typescript and evidence from the Court of Enquiry. It has been described by various historians as an ugly and unnecessary incident in South Australia’s history. (NAA Series MP367/1 Item 567/3/2202; Harmstorf 1985, pp. 23-28; Fischer 1989, pp. 194-198)

Most historical accounts of the Torrens Island internment camp have missed the fact that it was moved. It has frequently been stated that the site of the internment camp was on the south end of Torrens Island about 3km south of the quarantine station, on the site where the power station now stands. One of the first published historical accounts of the internment camp wrote, "Today a power station sits on the site and there is nothing on this mangrove island to tell us or succeeding generations of the notorious camp which was there." (Harmstorf & Cigler 1985, p. 129) A conservation plan for the Quarantine Station said, "The site of the internment camp, on the only land not flooded at high tide on the southern tip of the island, is now occupied by the ETSA power station". (McDougall & Vines 1988, p. 19) The Heritage Branch file summary repeats this information: "The site of the first quarantine station, now occupied by a power station, was used as an internment camp during the First World War". A recent account said, "well over 300 people were interned at the former Quarantine Station on the southern end of Torrens Island .... This internment camp (on the site of the present power station) was regarded as the worst in Australia." (Paech 2001, p. 13)

However, the evidence from the 1916 enquiry described two camp sites. The evidence says, "The camp was first established on Torrens Island shortly after the commencement of hostilities. The site selected was in safe proximity to the buildings comprising the State Quarantine Station". (In fact it had been a Commonwealth Quarantine Station since 1909.) Elsewhere the evidence says, "The camp was situated at 500 yards from the Quarantine Station." At the time the Quarantine Station had the only jetty on the island, so was the most convenient place to land stores and people. Presumably the first camp site was south of the Quarantine Station. This would put it near the point where the present road along the west shore of the island turns inland, about 500m south of the former Quarantine Station buildings.

In about March 1915 the camp was shifted. The reason is not given, but was presumably because its close proximity would compromise the Quarantine Station in the event of a quarantine emergency. The Court evidence says, "The Camp about this time was removed from the site which this Court has already described, to the southern end of the island, near an old quarantine station which had been unused for many years." This description suggests that the first human quarantine station of the 1850s may have been at the south end of Torrens Island, on the site which later became the cattle quarantine compound, and is close to the site where the power station was built in the 1960s. However, the 1916 evidence did not say that the internment camp was shifted **to** the site of the old quarantine station, it said it was shifted "to the southern end of the island, **near** an old quarantine station".

That description is the most accurate location for the second camp that the documentary evidence provides. However, there is pictorial evidence which was tendered at the Court of Enquiry of 1916, and exists in the National Archives and in the SA State Library. These take the form of a set of photographs made by internee Paul Dubotzky, and a pencil sketch of the camp under Captain Hawkes' command, which enable us to see what the camp occupied from March to August 1915 looked like.

Dubotzky's photographs of the camp and the pencil sketch show a neat rectangle parallel to the shore, with about 49 bell tents arranged in seven rows of seven. The kitchens and other facilities are makeshift huts. Some of the photographs look south-east across the narrow channel of the North Arm, with the mangroves of Garden Island in the middle ground, and the Adelaide Hills in the distance. The site of the camp appears to be under or close to the switchyard of Section B of the Torrens island Power Station.

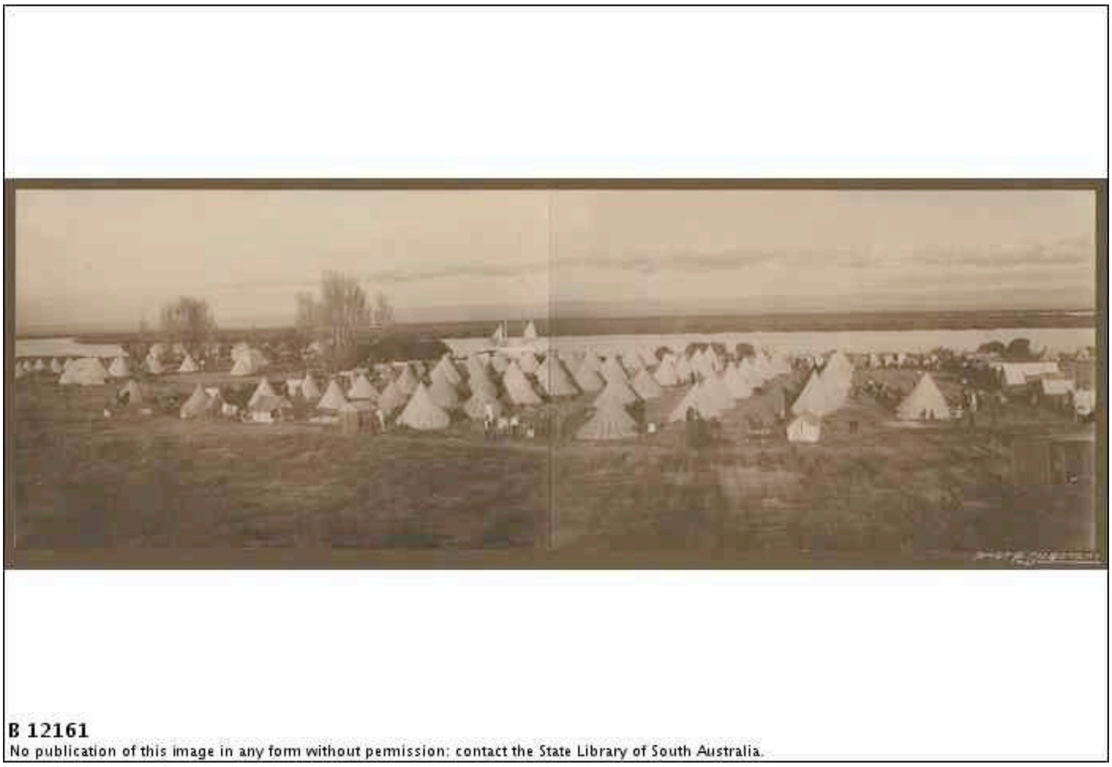


Figure 6 Panorama of the second Internment Camp, early 1915. The view is toward the southeast. (Source: SLSA B12161. Image courtesy of the State Library of South Australia.)

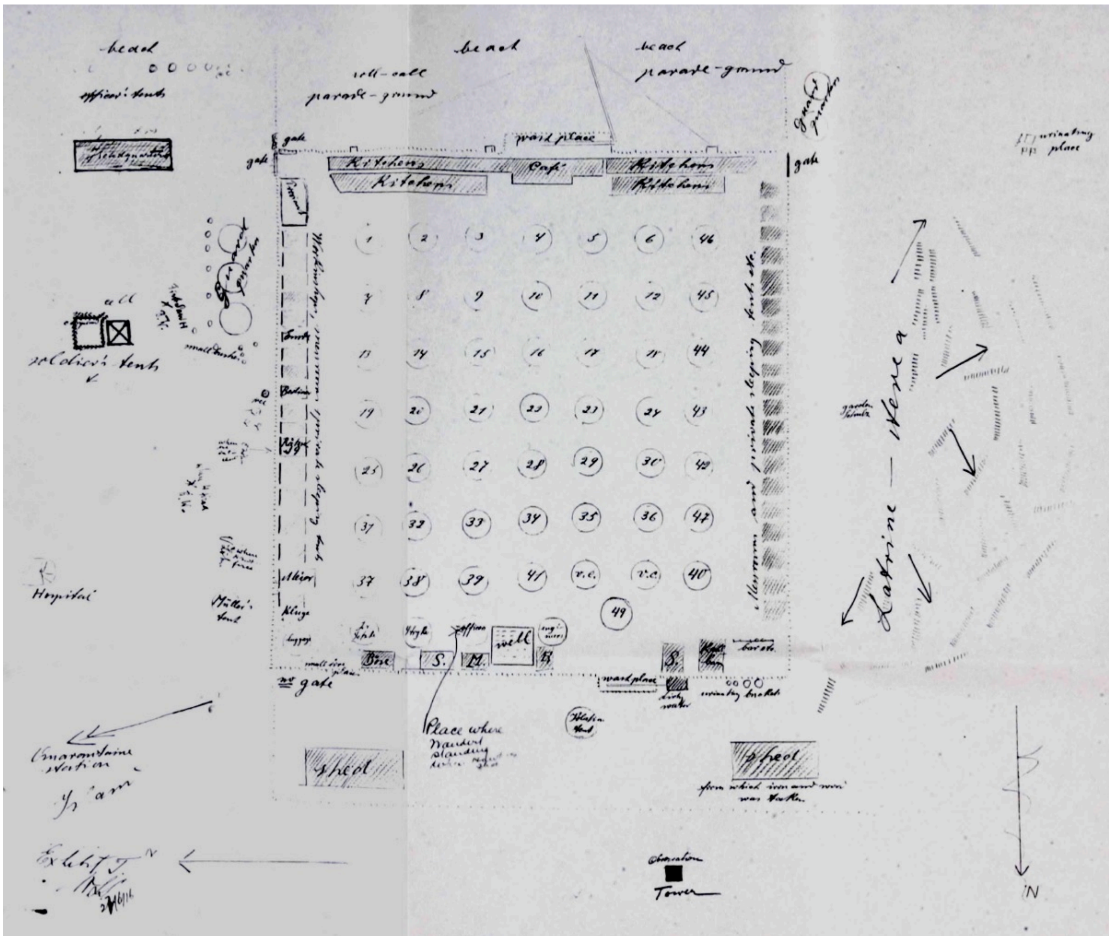


Figure 7 Plan of the second Internment Camp, 1915. (Source: NAA Series MP367/1 Item 567/3/2202)

Figure 8 Kitchen facilities in the Internment Camp. (Source: SLSA B46794. Image courtesy of the State Library of South Australia.)

There are also some photographs of the camp which show a wider river channel in the background. These were probably taken at the first camp site, looking west across the Port River, but there is not enough detail in the photographs to locate that camp more accurately.

2.4.7 Ships Graveyards

The shallow waterways around Torrens Island were used to dump disused watercraft, ranging in size from harbour workboats to ocean-going cargo vessels. Between 1909 and 1945, about 25 vessels were abandoned in the North Arm, along the southern shore of Garden Island, with more in Angas Inlet between Torrens Island and Garden Island, and in the main channel of the Port River. These areas are protected under the SA *Historic Shipwrecks Act*, and promoted to visitors as a maritime heritage trail. The single most significant wreck, the iron-hulled clipper *Santiago* (1856), is also in the Register of the National Estate.

2.4.8 Torrens Island Power Station

Until the 1960s, no high-quality hydrocarbon fuels were known in South Australia, and all reticulated electricity services were dependent on imported coal. Electricity supply progressed through the SA Electric Light Company's power station at Port Adelaide in 1897, a larger one in Grenfell Street in 1901, Osborne A beside the Port River in 1923, and the larger Osborne B in the late 1940s, but all were fuelled by black coal imported from New South Wales. There was a prospect of local hydrocarbon fuels when drilling began in the Cooper Basin in 1958, and the first gas flow was struck in the Gidgealpa field in 1963.


Figure 9 Aerial view of the power station site, c. 1963. (Source: Linn 1996, p. 139)

A new power station was under construction on the southern end of Torrens Island by 1963. The first bridge to the island was built for the construction project. It was anticipated that natural gas would be available within the next few years, and the furnaces were designed to be fuelled by oil in the short term, but to be converted to gas firing when it became available. The first unit of Section A at Torrens Island (one-eighth of the existing power station) began generating in 1967, with three more units coming on stream in 1968, 1969 and 1971. The power station was officially opened by Premier Don Dunstan on 28 February 1968. In the meantime a treatment plant was being built at Moomba, and an underground gas pipeline connected it to Adelaide during 1968-69. Gas from the Gidgealpa field flowed to Torrens Island in November 1969. Section A was duplicated over the next few years, with the first two units of Section B under construction by 1973. The first of the two landmark 160m stacks was built in 1967, the second in 1975. Both sections of the Torrens Island power station were completed to their present form by 1981. (ETSA 1967, 1973 & 1992; Linn 1996, pp. 137-38 & 154)

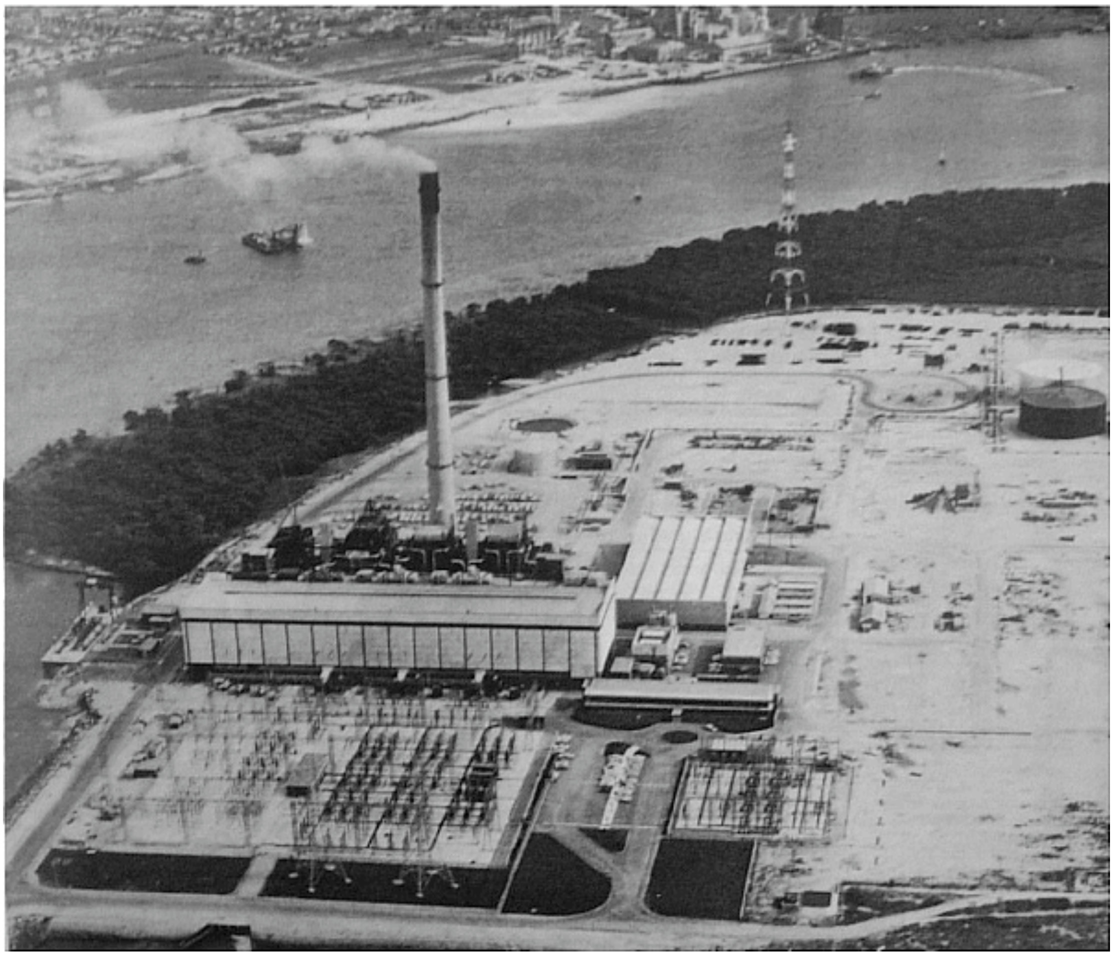


Figure 10 Aerial view of Section A under construction, c. 1968 (Linn 1996, p. 157)

2.4.9 Quarantine Power Station

In 1999, Origin Energy built a second power station on Torrens Island, making use of the Moomba gas pipeline running down the western side of the island to the ETSA power station. The new power station was sited in the midst of the old Quarantine Station, between the human and animal sections. The buildings of the Venereal Diseases Hospital of the former Quarantine Station were demolished to form the site of the power station. In 2008, the size of the power station was doubled.

2.4.10 Sand Quarrying

After construction of a bridge to Torrens Island in 1963, sand had been taken from the western side of the island for use as landfill. A geological investigation by the Department of Mines and Energy in 1984 showed that there were several hundred thousand tonnes of sand suitable for a number of purposes. (Flint 1984) An extensive area of sand about a kilometre north of the ETSA power station was quarried by the Coastal Management Branch for beach replenishment between 1988 and 1990. 187,500 cubic metres of sand was trucked to Glenelg North beach. A series of regular excavations can be seen beside the road to the Quarantine Station.

2.4.11 Torrens Island Conservation Park

The northern and eastern sides of Torrens Island taper off into an inter-tidal salt marsh with low mangrove woodland. The extreme northern tip of the area was declared a Conservation Park in the Schedule to the SA *National Parks and Wildlife Act* 1972. The park was also entered in the Register of the National Estate in 1980. The boundaries of the park were extended southward to take in the rest of the inter-tidal zone in 2005, so that it now covers most of the island except for the dune formation along the western shore.

2.4.12 Garden Island Waste Disposal

Since 1982 the Western Region Waste Management Authority, representing the councils in the west of Metropolitan Adelaide, have been dumping waste on Garden Island. In the process the island has been raised from inter-tidal wetlands to a landform 10m or more in height. Waste dumping ceased in 2001, and the area is now being remediated. (*Portside Messenger* 3 September 2008)

3.0 SITE SURVEY

3.1 Documented Sites

The background research indicated that there were no known or listed historic heritage sites within the study area.

The research also indicated that development within the study area prior to the construction of the power station had included a dairy farm (1847-75), possibly the site of the first quarantine station (1850s to 1860s/1870s), the second site of the First World War internment camp (March – August 1915), and animal paddocks for quarantine purposes associated with the Quarantine Station (1879-1909). It was considered unlikely that any of these items would have left significant or tangible structural or archaeological surface evidence.

Research undertaken for this project has ascertained that the internment camp was initially located just south of the Quarantine Station site but was then moved further to the south to the vicinity of the power station. Detailed study of the surviving historical photographs indicates that the internment camp is likely to have been sited under the TIPS Section B Switchyard and/or the existing roadway fronting Angus Inlet and as such is not in the current study area. It is also highly likely that the first quarantine station was also located on the same site as the power station.

3.2 Field Survey

A field survey was undertaken by Justin McCarthy and Peter Bell on 13 October 2009. Mr Rychard Oleszczyk from AGL initially guided the survey team to show the extent of the study area and to identify the location of the footprint location of the proposed LNG Tank and LNG Plant.

The survey team then inspected the proposed LNG Tank and LNG Plant sites on foot by walking transects over them. The northern part of the study area was inspected by random incursions on foot undertaken from the road running along its eastern and north eastern sides. At the northern end vehicle access was gained along a vehicle track as far the Osborne Gas Regulator Station compound and then a foot survey of the surrounding area was undertaken.

The day was wet with a strong wind warning issued by the Bureau of Meteorology making field survey conditions difficult although this did not diminish the diligence of the survey. The ground is generally open and sandy and covered with either low scrub or grasses and shrubs. Visibility was generally good.

3.3 Results

3.3.1 Documented Sites

No remains of any of the documented historic sites were revealed in the survey.

3.3.2 Recorded Sites

Two new sites were noted in the survey. The first lies within the footprint of the proposed LNG Plant while the second is located along the western side of the road to the Quarantine Station about 600m away, to the northeast of the proposed LNG Tank site (see Figure 11). The locations of the sites were recorded with a handheld GPS (set to WGS 84 datum) that indicated an accuracy of 5m when the readings were taken.

Site 1 (GPS 54H 0273418 UTM 6146076)
This site consists of three elements – two heavy machinery bases or foundation blocks of different design and a row of nine driven concrete piles arranged in a line.

The eastern foundation block measures approximately 1.0m wide x 2.0m long x 1.0m high and is made of rough cast concrete. It has a mound of soil on top but at least two large

(25mm) bolts are protruding from the upper surface. These appear to be holding down bolts for a large piece of machinery. This feature appears to be *in situ*.

The western feature measures approximately 3.0m wide x 4.0m long x 2.0m high. It consists of a larger composite base made from poured concrete and hard red machine-made bricks (with a “B” frog), supporting two parallel rectangular concrete walls that in turn support a section of railway type track. This feature is slightly raised off the ground and may have been dumped here as opposed to being located *in situ*.

The row of nine upright concrete piles runs in north east – south west alignment between the two machinery bases. The piles are hexagonally shaped and feature a steel collar at the top end. They appear to have been driven *in situ*. It is not clear why the piles have been driven in in this location. Some of the piles appear to be dated 1964 via inscriptions made in the concrete when it was wet.

Site 2 (GPS 54H 0273297 UTM 6146757)
This is a collapsed small pile driver[1]. It is a simple traditional style pile driver constructed of Oregon timber and has steel guides for the weight. It has toppled over and is lying on its side. One of the main side frame timbers is engraved “No 1 - 02”. It is collapsed and partially dismantled but appears to have originally been about 6m in height. The item is in poor condition.

There are concrete Besser style blocks at the base of the pile driver (that were probably part of its foundations) and a survey marker located between them.

The survey marker consists of a square concrete base with an upright piece of water pipe embedded in it. The concrete base is engraved with “MH” or “HW” (depending which way up it is read) with an arrow between the letters, and an aluminium tag stamped “6628 38421”.

[1] A pile driver is a mechanical device used to drive piles into soil to provide foundation support for buildings or other structures. A traditional type of pile driver includes a heavy weight placed between guides so that it is able to freely slide up and down in a single line. It is placed upon a pile. The weight is raised, which may involve the use of hydraulics, steam, diesel, or manual labour. When the weight reaches its highest point it is then released and smashes on to the pile in order to drive it into the ground.

Figure 11 Plan of site locations. Site 1 is the lower site closest to the power station. (Base aerial view from Google Earth)

Figure 12 General view of Site 1 to the north. DSCN 2598

Figure 13 Detail of eastern feature at Site 1 to north. DSCN 2599

Figure 14 Detail of western feature at Site 1 to northeast. DSCN 2605

Figure 15 Detail of top of a pile at Site 1 showing date. DSCN 2602

Figure 16 General view of Site 2 to the northwest. DSCN 2623

Figure 17 Detail view of the pile driver at Site 2 to the southeast. Note the steel guides fixed to the main timbers and the besser-style blocks. DSCN 2625

Figure 18 Detail view of the engraved mark on the side of one of the timbers of the pile driver at Site 2. DSCN 2630

Figure 19 Detail view of the survey marker at Site 2. DSCN 2629

4.0 SIGNIFICANCE

4.1 Introduction to the Significance Assessment Process

An assessment of significance seeks to determine and establish the importance or value that a place, site or item may have to the community at large. The concept of cultural significance is intrinsically connected to the physical fabric of the item or place, its location, setting and relationship with other items in its surrounds.

The assessment of cultural significance is ideally a holistic approach that draws upon the response these factors evoke from the community. These standardised aspects of significance assessments are generally applied to sites, places or items that have tangible historic structures or relics visible at the site, and where there is general understanding of the extent of the historic resources.

4.2 Basis for Assessment

The *Australia ICOMOS Charter for the Conservation of Places of Cultural Significance* (the Burra Charter) was formulated in 1979 and most recently revised in 1999, and is the standard adopted by most heritage practitioners in Australia. The Charter divides significance into various groups or categories for the purpose of assessment. They are: Aesthetic, Historical, Scientific/Technical, Social and Other.

4.2.1 State Listing

The South Australian Heritage Register has a separate set of significance assessment criteria. To be assessed for listing on the Heritage Register, an item would need to meet one or more of the following criteria under Section 16 of the *Heritage Places Act 1993:*

a) It demonstrates important aspects of the evolution or pattern of the State's history.
b) It has rare, uncommon or endangered qualities that are of cultural significance.
c) It may yield information that will contribute to an understanding of the State's history, including its natural history.
d) It is an outstanding representative of a particular class of places of cultural significance.
e) It demonstrates a high degree of creative, aesthetic or technical accomplishment or is an outstanding representative of particular construction techniques or design characteristics.
f) It has strong cultural or spiritual associations for the community or a group within it.
g) It has a special association with the life or work of a person or organisation or an event of historical importance.

Neither of the two sites recorded in the survey are considered to meet any of these criteria for State Heritage Listing.

4.2.2 Local Listing

A Development Plan may designate a place as a place of local heritage value if it satisfies one or more of the following criteria (from Section 23 (4) of the *Development Act 1993*):

1. It displays historical, economic or social themes that are of importance to the local area.
2. It represents customs or ways of life that are characteristic of the local area.
3. It has played an important part in the lives of local residents.
4. It displays aesthetic merit, design characteristics or construction techniques of significance to the local area.
5. It is associated with a notable local personality or event.
6. It is a notable landmark in the area.
7. In the case of a tree (without limiting a preceding paragraph) - it is of special historical or social significance or importance within the local area.

Neither of the two sites recorded in the survey are considered to meet any of these criteria for Local Heritage Listing.

4.2.3 Archaeological Potential

An assessment of archaeological potential usually considers the historic sequence of occupation and use and the impact that more recent constructions and works would have had on the earlier occupation phases. In regard to the present archaeological assessment of the proposed development area on Torrens Island, the archaeological potential depends upon the anticipated likelihood for survival of buried structural fabric and cultural deposits and an estimation of their archaeological integrity.

The potential for archaeological resources within the study area has been estimated in terms of the potential for buried structural fabric and the potential for cultural deposits. Structural fabric refers to what is generally regarded as building or civil engineering remnants while cultural deposits refer to archaeological deposits, *ie* deposited sediments containing artefacts.

The archaeological potential of the two surface sites identified in the study area is considered to be nil to low.

The archaeological potential of former features located in the study area (a dairy farm and animal paddocks for quarantine purposes) is also considered to be nil to low.

5.0 IMPACT ASSESSMENT

5.1 Proposed Works

The proposed expansion of the facilities at TIPS is likely to require significant structural works. Although construction details are not yet available, major preparatory works prior to construction are likely to include clearing, levelling, excavation, filling and compaction. All of these works will change the nature and character of the study area.

5.2 Impact Assessment

The two surface sites noted in the survey are likely to be removed during the construction process.

If either of the historically noted developments (the dairy farm and the animal quarantine paddocks) have below-ground remains, it is likely that they would be removed during the construction process.

The former Quarantine Station is located approximately 1500 metres to the north of the study area and is listed on the State Heritage Register. Works proposed in the study area will not have any impacts on this heritage item.

6.0 CONCLUSIONS & RECOMMENDATIONS

6.1 Conclusions

The background research indicates that there are no known or listed historic heritage sites within the study area.

This study has found that prior to the construction of the power station, historic activities in the study area included a dairy farm, possibly the site of the first quarantine station and paddocks for quarantining animals. No evidence of these activities was noted in the field survey. If below-ground remains of these features do survive, their archaeological potential is considered to be nil to low.

Two unrelated surface sites were identified in the field survey programme:

Site 1 comprises two heavy machinery footings and a row of concrete piles; the function of these items has not been ascertained but they are believed to date to the construction period of the power station and to post-date 1963. These items are considered to have neither heritage significance nor archaeological potential.

Site 2 comprises the collapsed remains of a small timber pile driver and a survey marker. The period of use of the pile driver has not been ascertained. These items are considered to have neither heritage significance nor archaeological potential.

These sites and features are not considered to meet any criteria for heritage listing as either State or Local heritage items.

A nearby feature, the Torrens Island Quarantine Station, is listed on the State Heritage Register (No 13931) and on the Register of the National Estate as an Indicative Historic Place (No 14866). It is considered that the proposed works in the study area will not have adverse impacts on the heritage values of this place.

In summary it is concluded that there are no significant non-indigenous cultural or historical items or areas of potential sensitivity that will be impacted by the proposed development.

6.2 Recommendations

- No further assessments regarding non-indigenous cultural or historical items are required within the designated study area;
- As required by Section 27(2) of the SA *Heritage Places Act* 1993, if historical archaeological relics not predicted by this report are found during any future works within the study area, all works in the immediate vicinity should cease immediately and the SA Heritage Council be notified and consulted. Penalties apply for breaches of this provision.

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Verbal Information

Tor Bakkeland, Torrens Island Avian Quarantine Facility
Carol Hutchens, Coastal Management Branch
Rychard Oleszczyk, Torrens Island Power Station
Gabriella Szondy, Torrens Island Power Station

8.0 Appendix 1 Heritage Listings

1. Torrens Island Quarantine Station

2. Torrens Island Conservation Park

Home / Heritage Places Database Details

Heritage Places Database Details

Location

Map	Link to Map
Address	Off
Suburb	OUTER HARBOR
Locality	
Accuracy	H - high level confidence
Development Plan	Land Not Within a Council Area (Metro)
Polygon Type	D - item has been digitised (generally because it doesn't exist in a DCDB parcel, eg. bridge

Status

Status Code	REG - Confirmed as a State Heritage Place in the SA Heritage Register
Status Date	21-Oct-1993

Description

Details	Torrens Island Quarantine Station (including Jetties, Cemetery, Mortuary & Complex)
Significance	Torrens Island has been the site of the continuous practice of animal quarantine in South Australia since the early 1850s. Animal quarantine was moved to the present site in 1909 from the south end of the island. The Station also represents South Australia's origins as a separate colony and records the development of medical practices in controlling infectious diseases as related to the relevant Parliamentary Acts for Quarantine in South Australia and the Commonwealth, which assumed responsibility after federation. The site of the first Quarantine Station, now occupied by a power station, was used as an internment camp during the First World War, but there are no obvious remains of those activities. The complex includes an 1870s prefabricated timber cottage, the only survivor of the original thirty, which is quite rare.
Subject Index	Health - Quarantine Station; Transport (Water) - Jetty; Cemeteries and burial sites - Cemetery; Cemeteries and burial sites - Morgue/Mortuary
Class	S - State Heritage Place

Reference

LGA	Unincorporated SA
Heritage ID	13931
DPLG ID	17297
ID code	H0100090

Valuation

Valuation Information (2007)	0707000100 0707000266 0707000303

Plan Parcel & Title

As listed in the SA Heritage Register

Plan Parcel & Title Information	CT 5973/989 D59977 A114

Australian Government
Department of the Environment, Water, Heritage and the Arts

Heritage
Australian Heritage Database

You are here: Environment home » Heritage » Australian Heritage Database

Place Details

new search

Send Feedback

Torrens Island Conservation Park, Outer Harbor, SA, Australia

Photographs:	
List:	Register of the National Estate
Class:	Natural
Legal Status:	Registered (21/10/1980)
Place ID:	6255
Place File No:	3/01/033/0001

Statement of Significance:

The marshes breed a myriad of worms, shrimps and simple organisms on which fish feed, helping to stock the Port River for fishing and providing food for over forty species of birds. The latter include a number of rare or uncommon summer visiting waders, ie. TRINGA TEREK (terek sandpiper), LIMOSA LAPPONICA (bar-tailed godwit), NUMENIUS MINUTUS (whimbrel) and PLUVIALIS DOMINICA (lesser golden plover) (SAOA, 1976).

(The Commission is in the process of developing and/or upgrading official statements for places listed prior to 1991. The above data was mainly provided by the nominator and has not yet been revised by the Commission.)

Official Values: Not Available

Description:

Situated at the northern end of Torrens Island, which lies near the mouth of the Port River, this park preserves a salt-marsh land system. The vegetation comprises a low woodland of AVICENNIA MARINA var. RESINIFERA (white mangrove) and low-shrubland of SALICORNIA spp. and ARTHROCNEMUM. Over thirty species of salt tolerant plants have been recorded for the Park.

History: Not Available

Condition and Integrity:

The Park is relatively undisturbed, although rabbits, which cross from the mainlands at low tide, are very common on the Island.

Location:

Approximately 72ha, northern section of Torrens Island, Gulf of St Vincent, Outer Harbor.

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