Report

Local Air Quality and Greenhouse Gas

Tarrone Power Station

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Prepared for

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Introduction

AGL Pty Ltd (AGL) propose the construction of a peak loading power plant near to Tarrone in south western Victoria. The peak loading power plant will be operated approximately 5% of the year with an operating capacity of between 720 MWh and 840 MWh dependant on the final choice and number of operating turbines.

At this stage in the design process, the final choice of engine manufacturer has not been determined, however two prospective manufacturers are being considered. In order to provide flexibility in the final choice of supplier, URS has considered the:

- Local air quality impact; and
- Greenhouse gas emissions

from the use of engines from the prospective manufacturers. The two proposed site designs considered by URS are:

- 4 X Alstom 13E2 M; or
- 3 X GE Energy 9FA.

The impact on ambient air quality with respect to regulatory emission limits and ground level concentration criteria of the primarily gaseous emissions has been assessed by URS. The local air quality assessment involved atmospheric dispersion modelling and has been conducted in accordance with the State Environment Protection Policy for Air Quality Management (referred to herein SEPP(AQM)). The assessment of the impact of local air quality used a largely conservative approach, in accordance with the SEPP(AQM).

Local Environment

2.1 Climate and Meteorology

Three Bureau of Meteorology sites are located close to the proposed site at:

- Mortlake Racecourse;
- Portland; and
- Warrnambool.

These data indicate that the region experiences moderately warm summers with average daytime temperatures around 25°C with occurrences of hot conditions to a maximum recorded temperature of 46°C. Average daytime winter temperatures are approximately 13°C with recorded night time minimums reaching lows of approximately -5°C.

Annual winds are found to occur from all directions, with northerly winds more frequent than other directions. During the summer, the afternoon is dominated by southerly winds indicative of a strong influence of sea breezes.

The area has an annual mean rainfall of approximately 550mm with, on average, 96 days of rain with greater than 1mm recorded.

2.2 Background Air Quality

To URS' knowledge, the area has no permanent background monitors in place for the measurement of ambient air quality. Background air quality has been measured in Warrnambool by EPA and Mount Gambier by the South Australian EPA.

2.2.1 Warrnambool Background Air Quality

EPA measured particulate concentrations and ozone in Warrnambool from October 2006 to October 2007. Warrnambool was found to have generally good air quality with high levels of particulate resulting in the objective for visibility being exceeded on 13 days and the PM10 objective on 3 days. The episodes of high particulate levels were attributed to bushfires in the north-east of Victoria and wood smoke from the use of domestic fires. Data on levels of PM2.5, or other common anthopogenic species were not reported in this round of monitoring.

2.2.2 Mount Gambier Background Air Quality

The South Australian EPA measured background air quality in Mount Gambier at three sites from September 2001 to August 2002. Species monitored included:

- Nitrogen dioxide;
- Sulphur dioxide;
- Carbon monoxide;
- PM_{10};
- Formaldehyde; and
- Benzene.

Two of the sites were located adjacent to industrial areas, and the third site was located next to the main road through Mount Gambier. The monitoring locations were selected by the South Australian EPA to determine the impact from industry and the roads and to establish whether the emissions resulted in air pollution 'hot spots' in Mount Gambier. As such the data does not conform to the

Australian Standard for the placement of background monitors required for compliance with NEPM, and URS does not, therefore, consider these results to be representative of background air quality surrounding the site.

2.2.3 Background Air Quality Used for Assessment

Monitoring undertaken in Warrnambool by EPA does not provide data on species likely to be emitted from the proposed power station, and data collected by the South Australian EPA in Mount Gambier is not considered to be representative of the project site.

In these circumstances, EPA recommends the use of the 70th percentile of available monitored data and provides a table of appropriate background levels for proponents to use in dispersion modelling. URS has used the background data, provided by EPA, from areas where data exists and is likely to be representative. It should be noted that this monitoring is based on an area with a higher residential population and a high number of vehicle movements, than the model domain. The background concentrations used in this assessment are therefore considered to be conservative. Table 2-1 shows the background concentration used in this assessment for each species, the source of the data and a comment on the appropriateness of the selection.

Table 2-1 Background concentrations for common species provided by EPA as representative background values

Species	Background Concentration (µg/m^3)	Location of Background Measurement	Comment
NO_2	11.3	Point Cook	Suburban area with little industrial activity or residential population at the time of monitoring (2000). Considered representative.
$PM_{2.5}$	7.5	Brighton	Urban area with high residential population. Large number of vehicle movements. Considered appropriate but likely to be conservative compared to modelled area.
CO	0.22	Geelong	Low density residential surrounding monitoring point at time of monitoring (2000). Considered representative.
SO_2	0	Geelong	Low density residential surrounding monitoring point at time of monitoring (2000). Considered representative.

2.3 Other Sources

The region is mainly rural in nature with local industrial areas in and around the larger towns of Portland and Warrnambool. Emissions from these industrial areas, would not be expected to contribute significantly to local ambient air quality.

The main roads in the local area are infrequently trafficked and not expected to result in significant contribution to local air quality. Impacts from the local road network have not been considered as part of this assessment.

Criteria

3.1 Regulatory Framework

This section discusses the regulatory framework for managing air quality in Victoria. Only species that will be emitted to atmosphere from the peak load power station under normal operations are considered.

3.2 National Environmental Protection Measure (Ambient Air Quality)

The National Environment Protection (Ambient Air) Measure (Ambient Air NEPM) provides the goals for ambient air quality that need to be achieved nationwide. Table 3-1 provides the Ambient Air NEPM goals for key air quality indicators relevant to the project. The NEPM standards are intended to be applied at monitoring locations that represent air quality for a region or sub-region of more than 25,000 people. The Ambient Air NEPM was released in 1998[1].

Table 3-1 EPP (Air Quality) 2004, Clause 7 – Schedule 2 of Ambient Air NEPM

Pollutant	Averaging Time	Air Quality Standard	Goal within 10 years – Maximum Allowable Exceedances
Carbon Monoxide (CO)	8-hour	9 ppm	1 day a year
Nitrogen Dioxide (NO_2)	1-hour	0.12 ppm	1 day a year
	1-year	0.03 ppm	none
Sulphur Dioxide (SO_2)	1-hour	0.20 ppm	1 day a year
	1-day	0.08 ppm	1 day a year
	1-year	0.02 ppm	none

3.3 State Environment Protection Policies

The State Environment Protection Policies (SEPPs) provide the framework for the protection of the environment in Victoria and have been enacted under Sections 16(1) and 16(2) of the *Environment Protection Act (Vic)* 1970. For air quality, two SEPPs exist, one for Ambient Air Quality (SEPP (AAQ)) and a second for Air Quality Management (SEPP (AQM)).

3.3.1 SEPP(AAQ)

For common pollutants within the atmosphere such as nitrogen dioxide (NO_2), particulate matter (PM_{10}), carbon monoxide (CO) and lead (Pb) generated by the combustion of fossil fuels or wood, the SEPP (AAQ) is the prevalent applicable SEPP. The main aim of the policy is compliance with Ambient Air Quality NEPM, and as such it contains standards that are considered to apply to monitoring data and concentrations modelled over an airshed rather than being applicable to local air quality standards.

With regards to the protection of local air quality, the prevalent SEPP is the SEPP (AQM).

[1] National Environmental Protection Council, National Environment Protection Measure for Ambient Air Quality, 1988, with amendment in 2003

3.3.2 SEPP(AQM)

The SEPP(AQM) is the instrument which the State Government uses to achieve the Ambient Air Quality SEPP Goals. The SEPP(AQM) provides design criteria for ground level concentrations which new or modified industrial sources must attain in order to comply with the Policy and the Environment Protection Act, 1970.

It is the policy intent of the SEPP(AQM) to manage the emissions to the air environment so that:

> '*the beneficial uses of the air environment are protected, Victoria's air quality goals and objectives are met, our air quality continues to improve and we achieve the cleanest air possible, having regard to the State's social and economic development*'.

The beneficial uses are defined as protection of the following:

- Life, health and well-being of humans'
- Life, health and well-being of other forms of life, including the protection of ecosystems and biodiversity;
- Local amenity and aesthetic enjoyment;
- Visibility;
- The useful life and aesthetic appearance of buildings, structures, property and materials; and
- Climate systems that are consistent with human development, the life, health and well-being of humans, and the protection of ecosystems and biodiversity.

The SEPP(AQM) defines design criteria (Schedule A) that are to be used in assessing the impact for new or modified sources. Table 3-2 shows design criteria relevant to emissions from the proposed peak load power station. Emissions of substances have been identified through turbine manufacture data and US-EPA emissions database AP-42 based on no control technology being used.

Table 3-2 SEPP (AQM) design criteria for relevant emitted substances

Substance	Averaging Period	Design Criteria (µg/m^3)
Nitrogen dioxide	1-hour	190
Carbon monoxide	1-hour	29,000
Sulphur dioxide	1-hour	450
Particles as PM_{10}	1-hour	80
Particles as $PM_{2.5}$	1-hour	50
Ammonia	3-minute	600
Formaldehyde	3-minute	40
Xylenes	3-minute	350
Acetaldehyde	3-minute	76
Acrolein	3-minute	0.77
Ammonia	3-minute	600
Benzene	3-minute	53
Ethylbenzene	3-minute	14,500
Polycyclic aromatic hydrocarbons (PAH) as BaP	3-minute	0.73
Toluene	3-minute	650

Methodology

4.1 Choice of Model

CALPUFF Version 6.263 was used as the atmospheric dispersion model for the assessment of the proposed AGL Power Plant at Tarrone in preference to the regulatory model, Ausplume Version 6.

The preference to use CALPUFF rather than Ausplume for this particular assessment was due to:

- the potential for sea breeze influences on plume behaviour; and
- the ability of CALPUFF to model sub-hourly emissions, which is a more accurate representation of the impacts from startup of the peak loading power plant.

4.1.1 Influence of Sea Breeze Circulation

Local meteorology was likely to be affected by sea breeze circulation at the proposed site location for the AGL power plant at Tarrone. URS considered it important that sea breezes be taken into account within the modelling assessment due to the potential for stack emissions to be transported out to sea in the morning and returned to areas over the land in the afternoon. URS believe Ausplume would have been unable to account for this circulation, as the model is based on Gaussian dispersion of emissions for each hour independantly. As a puff model, CALPUFF was able to track the emissions as puffs within the grid domain, meaning that a more accurate model result was determined where recirculation of air occurred.

4.1.2 Sub-hourly Modelling

Peak loading power plants do not operate continuously, and there are a number of start up conditions of the plant throughout the year. During startup, which usually takes approximately 30 minutes to full load, emissions of species, exit temperature and velocity vary significantly. The use of sub-hourly modelling allows a more accurate approach to assessing the impact of start-up conditions than the use of Ausplume which, like most dispersion models, allows one condition per hour to be modelled. The use of CALPUFF with sub-hourly modelling therefore affords more confidence in the modelled ground level concentrations for start up conditions compared to a single hourly condition using CALPUFF that is more likely to result in significant over estimation.

4.2 Meteorological Data

Meteorological data was prepared for the dispersion modelling using CALMET. CALMET is a meteorological pre-processor for the CALPUFF dispersion model that is able to take account of surface and upper air observations across a model domain and, using topographic and land use data, derive three dimensional meteorology across a model grid. The output from CALMET is then used in the dispersion modelling.

Observational data in the area surrounding the project site was available from:

- Mortlake Racecourse (surface);
- Portland (surface);
- Warrnambool (surface); and
- Mount Gambier (surface and upper air).

4 Methodology

The area surrounding Tarrone that the observational data covered was too large to form the final model domain. Therefore all observational data was included in the CALMET meteorological run using a coarse grid of resolution 5km over the extent of the monitoring locations . A second CALMET run was then used for a finer resolution grid (200m) to define the model domain. The output from the first CALMET run formed the initial guess wind fields for the final finer resolution model grid.

Pasquil stability classes define whether there is turbulence in the lower atmosphere that is likely to affect dispersion. Turbulence in the lower atmosphere is affected by wind speed, land use type and degree of solar insolation. Comparison of the atmospheric stability classes calculated by CALMET with a spreadsheet calculation found agreement between the two datasets providing confidence in the meteorological modelling.

4.2.1 Topography

Meteorological modelling using CALMET requires topographic information for the model domain. Topographic information was taken from data available from the Shuttle Ray Topography Mission (SRTM) that provides topographic data at a spatial resolution of 90m for the entire surface of the Earth. Topographic information for the model grid was extracted for the SRTM dataset using a Geographic Information System. This information was then translated to CALMET format using a macro in Excel.

4.2.2 Land Use

In addition to topographic information, CALMET also requires land use information in order to estimate surface roughness over the grid. Land use information was obtained from version 2.0 of the Australia Pacific Land Cover Characteristics Database available from the United States Geological Survey that provides land use data at a 1km resolution.

Land use information for the model grid was extracted from the Land Cover Characteristics Database using a Geographic Information System. This information was then translated to CALMET format using a macro in Excel.

4.3 Emission Rate Estimation

Emission estimation for the proposed power plant was completed using manufacturer data provided by AGL, and where manufacturer data was unavailable emission estimation was completed using techniques provided in the National Pollutant Inventory (NPI) and the USEPA emission estimation technique manual AP-42.

As discussed, at this stage in the proposal, the exact choice of engine manufacturer has not been defined. Emissions from the GE 9FA engine were determined to be higher than those from the Alstom 13E2. To account for the potential use of other engines, start-up and normal operational mass emission rates for the GE 9FA engine were increased by 10% to provide AGL with the flexibility to adopt a third engine design.

4.3.1 Start-up Emissions

Start up emissions for a peak loading power plant have potentially higher mass rates for a short durations due to lower efficiency of the engine during these conditions. It was found that the only species with a higher mass rate during start up than during normal operation is oxides of nitrogen (NO_X). Start-up emissions for NO_X were therefore calculated for both engines.

CALPUFF allows the use of sub-hourly meteorological data, meaning that time varying emissions for the same time period can be used to determine the potential ground level impacts due to start-up conditions.

Emissions of NOX during start up have been calculated for each engine type. Due to the different type of information provided by each manufacturer the method of calculation for start up NOX emissions was varied slightly with each engine.

Alstom 13E2

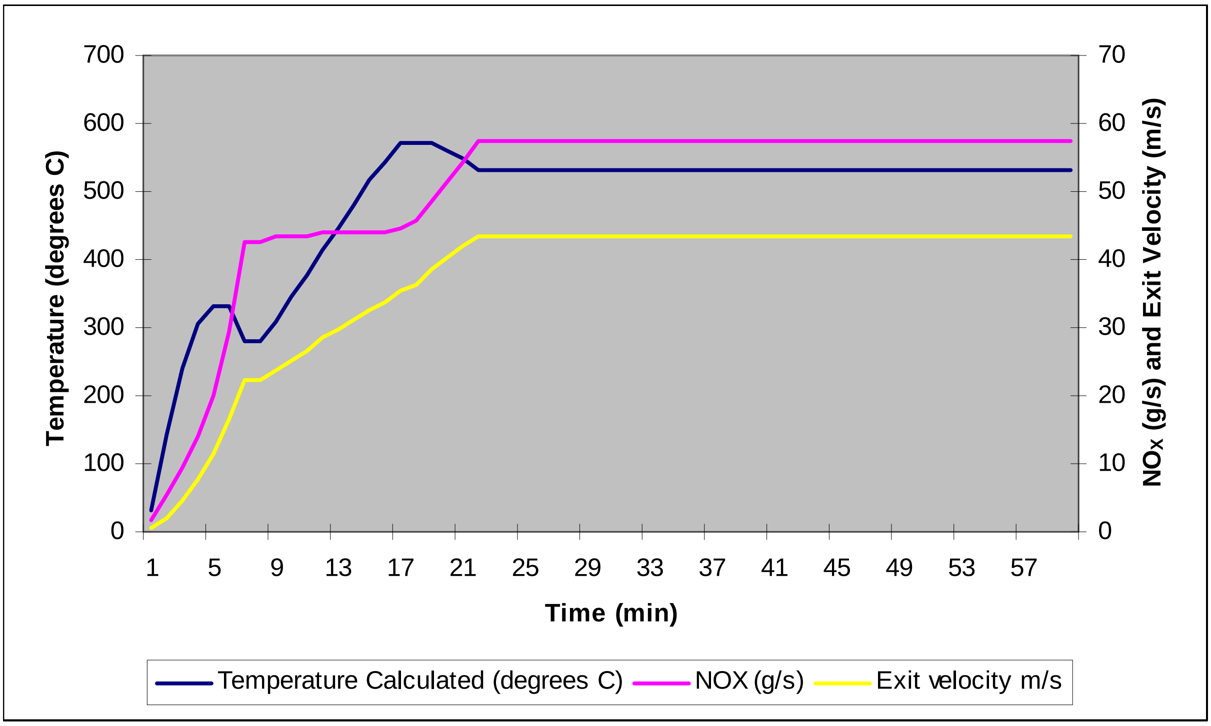
Start-up conditions for the Alstom 13E2 engines were based on start-up curves provided by the manufacturer that provided:

- Mass flow rate of stack emissions as a percentage of base load;
- Data on total emissions of NO_X over the start-up period (49 kg); and
- Variation in stack exit temperature.

In addition, an assumed gas density of 28.26g/mol, same as provided by GE, was used with variation in mass flow rate and the stack diameter to calculate the variation in velocity.

Figure 4-1 shows the time varying emission estimates included in the dispersion modelling for each hour to simulate start up in that hour.

Figure 4-1 Variation of stack exit temperature, NO_X emissions and exit velocity during start-up of the Alstom 13E2 engines



GE 9FA

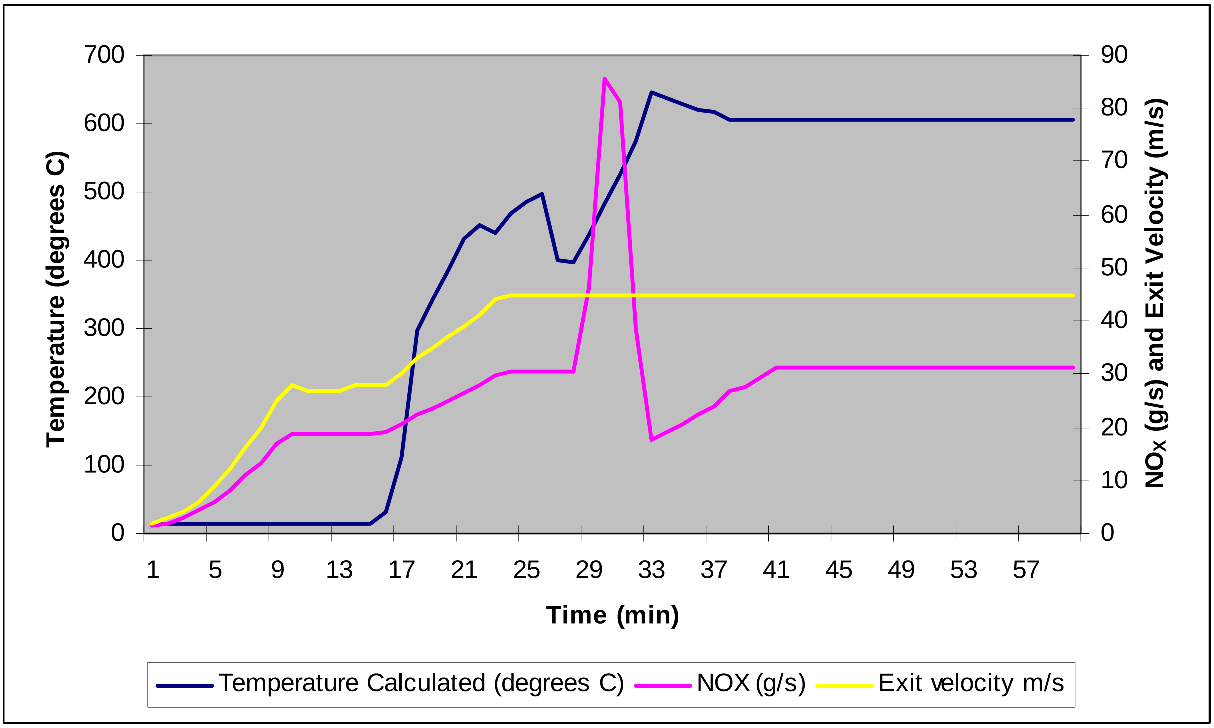
Start-up conditions for the GE 9FA engines were based on start-up curves provided by the manufacturer provide that:

- Percent load during start-up;
- Exhaust mass as a percentage of base load;
- NO_X emissions in relation to percentage load operation of the turbine; and
- Change of temperature over the start-up period.

In addition, a gas density of 28.26g/mol, provided by GE, was used with variation in mass flow rate and the stack diameter to calculate the variation in velocity.

Figure 4-2 shows the time varying emission estimates included in the dispersion modelling for each hour to simulate start up in that hour.

Figure 4-2 Variation of stack exit temperature, NO_X emissions and exit velocity during start-up of the GE 9FA engines



4.3.2 Base Load

Emissions during normal operations have been calculated using a combination of data received from the manufacturers, NPI and AP-42 emission estimation techniques.

Table 4-1 Modelled emission rates for Alstom 13E2 and GE 9FA engines (g/s)

Species	Alstom 13E2 (M) (g/s)	GE 9FA (PG9351) (g/s)
NO_X	20.86	30.62
SO_2	1.17	2.23
CO	2.56	9.14
$PM_{2.5}$	3.00	2.14
Benzene	0.003	0.005
Toluene	0.03	0.05
Ethylbenzene	0.01	0.01
Xylene	0.01	0.03
Formaldehyde	0.15	0.29
Total PAH	0.0004	0.0008

4.4 CALPUFF Setup

The following settings were used in the CALPUFF setup:

- Grid of 81 X 79 points at 500m resolution with the south-west corner at 583000, 5754000 (AMG);
- Wind speed profile – ISC Rural;
- Stack tip downwash;
- Partial plume penetration;
- Building wake effects; and
- Partial plume adjustment for terrain effects;
- Chemical transformation was not included; and
- Deposition was not included;

Stack tip downwash was included as this can potentially result in high ground level concentrations where the wind is strong enough to ground plumes.

The emitted plume is very hot and therefore buoyant, with a high velocity the potential for partial plume penetration of the boundary layer when the layer is close to the ground exists. It is therefore considered necessary to include partial plume penetration in the modelling.

Building wake effects have the potential to increase ground level concentrations when a plume becomes trapped in the recirculation zone generated by air flow over a building. Potential building wake effects were incorporated by using output from the BPIP module of Ausplume in the CALPUFF modelling.

Partial plume adjustment was included for any terrain effects. There is, however, no significant terrain in the model domain, and the use of partial plume adjustment is considered unlikely to result in a change to predicted concentrations had adjustment of the plume not been considered.

Note that chemical transformation and deposition were not modelled, as this provides a conservative assessment of potential impacts.

4.5 Calculation of Nitrogen Dioxide

During the combustion process, nitrogen from the air and fuel combines with oxygen in the air to form nitrogen oxide (NO) and nitrogen dioxide (NO_2) in the approximate ratio 90% NO to 10% NO_2. NO_2 is broken down by sunlight to form NO and an oxygen radical. The oxygen radical is highly reactive and combines with oxygen (O_2) to form ozone (O_3). O_3 is unstable and readily combines with NO to form NO_2 and O_2 (Equation 4-1). It may be seen from Equation 4-1 that the reaction series is circular, as such NO and NO_2 are often combined and termed oxides of nitrogen (NO_X).

Equation 4-1 Formation of Secondary NO2

$$NO_2 \xrightarrow{hv(\lambda 295-430nm)} NO + O^{\bullet}$$

$$O_2 + O^{\bullet} \xrightarrow{M} O_3$$

$$NO + O_3 \longrightarrow NO_2 + O_2$$

Where:

NO_2 is nitrogen dioxide	NO is nitrogen oxide	$O^{\bullet}$ is an oxygen radical	hv is light
λ is wavelength	O_2 is Oxygen	M is any molecular form	O_3 is Ozone

Whilst NO is innocuous at concentrations commonly found in the atmosphere in urban areas and surrounding industrial facilities, concentrations of NO_2 are known to have an effect on human health at much lower levels. Ambient criteria for NO_2 have accordingly been set by EPA.

To account for potential conversion from NO to NO_2 total emitted NO_X is traditionally modelled and, in the first instance, all NO_X is considered to be NO_2. This is an over-estimation of the impacts, however, if predicted concentrations are determined to be below criteria, with this over-estimation, the beneficial use of the atmosphere is considered to be preserved.

4.6 Greenhouse Gas Emissions

4.6.1 Regulatory Framework for Greenhouse Gas Emissions

A national approach to greenhouse gas (GHG) emission estimation and reporting has been established.

The National Greenhouse and Energy Reporting Act 2007 (NGER Act) establishes a national framework for reporting greenhouse gas emissions, greenhouse gas emission abatement actions and energy consumption and production by Australian corporations.

The *National Greenhouse and Energy Reporting Regulations 2008* (NGER Regulations) provide the necessary details that allow compliance with, and administration of, the NGER Act.

To estimate greenhouse gas emissions for compliance with the NGER Regulations and the NGER Act, the *National Greenhouse and Energy Reporting (Measurement) Determination 2008* (NGER (Determination)) sets out methods, and criteria for methods, for the estimation of greenhouse gas emissions. It also sets out methods for estimating or calculating the production and consumption of energy. Facilities are required to report under the NGER Act if they exceed the GHG emission threshold of 25 kt CO_2-e/year (kilotonnes of carbon dioxide-equivalent per year) or the energy threshold (produced or consumed) of 100 TJ/year.

The document "*National Greenhouse and Energy Reporting System: technical guidelines for the estimation of greenhouse emissions and energy at facility level: energy, industrial process and waste sectors in Australia*", 2007 provides additional guidance to the NGER (Determination).

Also relating to GHG emissions, by way of energy consumption, is the Energy Efficiency Opportunities Program (EEO) and related Act and Regulations which requires that facilities using more than 500 TJ of energy participate in the program. The program is designed to encourage participants to develop a detailed knowledge of their energy consumption and develop actions to reduce consumption.

4.6.2 Emission Scope

The methodology described in NGER (Determination), used for the assessment, was employed with the concept of emission "scopes".

- Scope 1: Direct GHG emissions. Direct GHG emissions occur from sources that are owned or controlled by the company, for example emissions from combustion in owned or controlled boilers, furnaces, vehicles, etc; and emissions from chemical production in owned or controlled process equipment.
- Scope 2: Electricity Indirect GHG emissions. This accounts for GHG emissions from the generation of purchased electricity consumed by the company. Purchased electricity is defined as electricity that is purchased or otherwise brought into the organisational boundary of the company. Scope 2 emissions physically occur at the facility where electricity is generated.
- Scope 3: Other Indirect GHG emissions. This is not a reporting class as required under the NGER Act and NGER Regulations. These emissions account for all other indirect GHG emissions resulting from a company's activities, but occurring from sources not owned or controlled by the company. Examples include extraction and production of purchased materials; transportation of purchased fuels; and use of sold products and services.

Scope 1 and 2 emissions together are called "total" greenhouse gas emissions for a facility. Scope 3 is not required to be reported to NGER.

4.6.3 Scope 1 and 2 Emissions

Scope 1 emissions from electricity generation have been calculated using the National Greenhouse Accounts (NGA) factors to provide data on the emissions of CO_2-e (carbon dioxide equivalent) generated through the combustion of gaseous fuels for power generation. The NGA factors take in to account emissions of the three main greenhouse gases, CO_2, CH_4 (methane) and N_2O (nitrous oxide) (Department of Climate Change, 2009).

For power generation, from natural gas distributed in a pipeline, an overall emission factor of 51.33 kg CO_2-e/GJ is provided by the NGA factors.

This emission factor has been used with the expected gas consumption in a year and the gas energy content to calculate the emission of CO_2-e as required by the NGA factors handbook (Department of Climate Change, 2009).

Scope 2 emissions include purchased electricity. The plant is an electricity generator, and therefore will not require purchase of electricity.

Results

Figures 1 to 12 show predicted contribution to ground level concentrations during startup and operation of the Alstom 13E2 and GE 9FA engines both separate from and in combination with the proposed Shaw River site.

Table 5-1 shows the maximum modelled ground level concentration (99.9th percentile), including background, in comparison to the SEPP(AQM) design criteria.

For all modelled scenarios and species the maximum modelled ground level concentration is below the SEPP(AQM) design criteria.

It is interesting to note that the maximum modelled ground level concentration for startup is lower than the maximum modelled ground level concentration for normal operations. This is due to modelling using a sub-hourly data set that allows the lower emissions than normal operations for the first 21 minutes and 9 minutes for the Alstom 13E2 and GE9FA respectively, to be incorporated into the modelling. Over the hour, the emissions during start-up are lower than during normal operations, in addition the variation in temperature and exit velocity means that the emission reaches varying final plume heights throughout the hour resulting in a lower ground level concentration as the plume is less well formed.

Results for species other than NO_X as NO_2 are not included in the results as emissions for these species are lower during startup than during normal operation. Only NO_X as NO_2 has a period when the emission rate is higher than during normal operation.

5 Results

Table 5-1 Maximum modelled (99.9th percentile) ground level concentrations for considered scenarios

Species	NO_X as NO_2	SO_X as SO_2	CO	$PM_{2.5}$	PAH as B(a)P	Benzene	Xylenes	Toluene	Ethyl-benzene	Formalde-hyde
Units	ug/m^3	ug/m^3	ug/m^3	ug/m^3	ug/m^3	ug/m^3	ug/m^3	ug/m^3	ug/m^3	ug/m^3
Averaging Period	1 hour	1 hour	1 hour	1 hour	3 minutes	3 minutes	3 minutes	3 minutes	3 minutes	3 minutes
Alstom 13E2 Steady State	27.41	0.86	2.19	9.81	0.001	0.003	0.018	0.037	0.009	0.203
GE 9FA Steady State	25.53	0.86	4.47	8.49	0.001	0.003	0.018	0.037	0.009	0.204
Alstom 13E2 Start up	14.45									
GE 9FA Start up	16.1									
Alstom 13E2 Steady State Plus Shaw River	35.75	1.31	3.22	11.01	0.001	0.005	0.014	0.056	0.014	0.309
GE 9FA Steady State Plus Shaw River	34.73	1.32	4.47	10.36	0.001	0.005	0.014	0.057	0.014	0.312
Background Concentration	11.3	0	0.22	7.5	0	0	0	0	0	0
SEPP (AQM) Design Criteria	**190**	**450**	**29,000**	**50**	**0.73**	**53**	**350**	**650**	**14,500**	**40**
Exceed SEPP (AQM) Design Criteria	No	No	No	No	No	No	No	No	No	No

5 Results

5.1 Scope 1 Greenhouse Gas Emissions

The long term average annual operating hours is expected to be approximately 440 hours per year (approximately 5% of the year) operated to supply electricity at times of high demand. At a 5% usage rate, the expected gas consumption would result in Scope 1 greenhouse gas emissions of 137,614 tonnes CO_2-e and 156,195 tonnes CO_2-e for the Alstom 13E2 and the GE 9FA designs respectively. This is approximately 0.17% and 0.19% of CO_2-e emitted by energy production in Victoria (Sustainability Victoria, 2009).

Conclusion

AGL Pty Ltd (AGL) propose the construction of a peak loading power plant near to Tarrone in south western Victoria. The peak loading power plant will be operated approximately 5% of the year with an operating capacity of between 720 MWh and 840 MWh dependant on the final choice and number of operating turbines.

At this stage in the design process, the final choice of engine manufacturer has not been determined, however two prospective manufacturers are being considered. In order to provide flexibility in the final choice of supplier, URS has considered the:

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The impact on ambient air quality with respect to regulatory emission limits and ground level concentration criteria of the primarily gaseous emissions has been assessed by URS. The local air quality assessment involved atmospheric dispersion modelling and has been conducted in accordance with the SEPP(AQM). The assessment of the impact of local air quality used a largely conservative approach, in accordance with the SEPP(AQM).

6.1 Background Data

Very little ambient monitoring has been undertaken in the area surrounding the proposed project site. URS understands that monitoring has been undertaken in industrial areas of Mount Gambier by the South Australian EPA and in Warrnambool for PM_{10} and TSP by the Victorian EPA. Data from Mount Gambier was considered not to be representative of the project site due to the industrial areas in which the data was collected. Monitoring in Warrnambool measured only PM_{10} and TSP. URS considers that any dust emissions from the power station are likely to be less than $PM_{2.5}$ due to the natural gas fuel source. Use of PM_{10} monitoring as background data for $PM_{2.5}$ would be an over estimate of background concentrations.

URS therefore selected appropriate locations from the 70^{th} percentile of monitored concentrations table for common species provided by EPA.

6.2 Methodology

6.2.1 Emission Estimation

Emission estimation for the proposed power plant was completed using manufacturer data provided by AGL, and where manufacturer data was unavailable emission estimation was completed using techniques provided in the National Pollutant Inventory (NPI) and the USEPA emission estimation technique manual AP-42.

CALPUFF allows the use of sub-hourly meteorological data, meaning that time varying emissions for the same time period can be used to determine the potential ground level impacts due to start-up conditions.

6 Conclusion

Emissions of NO_X during start up have been calculated for each engine type. Due to the different type of information provided by each manufacturer the method of calculation for start up NO_X emissions was varied slightly with each engine.

Start-up conditions for the Alstom 13E2 engines were based on start-up curves provided by the manufacturer that provided:

- Mass flow rate of stack emissions as a percentage of base load;
- Data on total emissions of NO_X over the start-up period (49 kg); and
- Variation in stack exit temperature.

Start-up conditions for the GE 9FA engines were based on start-up curves provided by the manufacturer providing:

- Percent load during start-up;
- Exhaust mass as a percentage of base load;
- NO_X emissions in relation to percentage load operation of the turbine; and
- Change of temperature over the start-up period.

6.2.2 Modelling

URS used CALPUFF Version 6.263 was used as the atmospheric dispersion model for the assessment of the proposed AGL Power Plant at Tarrone in preference to the regulatory model, Ausplume Version 6.

The preference to use CALPUFF rather than Ausplume for this particular assessment was due to:

- The potential for sea breeze influences on plume behaviour; and
- The ability of CALPUFF to use sub-hourly meteorological data which is a more accurate representation of the impacts of startup conditions for the peak loading power plant.

Meteorological data was prepared for the dispersion modelling using CALMET. CALMET is a meteorological pre-processor for the CALPUFF dispersion model that is able to take account of surface and upper air observations across a model domain and, using topographic and land use data derive three dimensional meteorology across a model grid. The output from CALMET is then used in the dispersion modelling.

Observational data in the area surrounding the project site was available from:

- Mortlake Racecourse (surface);
- Portland (surface);
- Warrnambool (surface); and
- Mount Gambier (surface and upper air).

6.2.3 Greenhouse Gas Estimation

National Greenhouse Accounts (NGA) factors provide data on the emissions of CO_2-e (carbon dioxide equivalent) generated through the combustion of gaseous fuels for power generation taking account of emissions of the three main greenhouse gases – CO_2, CH_4 (methane) and N_2O (nitrous oxide) (Department of Climate Change, 2009).

The emission factors were used with the expected gas consumption in a year and the gas energy content to calculate the emission of CO_2-e as required by the NGA factors handbook (Department of Climate Change, 2009).

6.3 Results

6.3.1 Ambient Air Quality

Predicted ground level concentrations for all species and all considered engine designs were below the relevant SEPP (AQM) design criteria.

6.3.2 Greenhouse Gas Emission

The long term average annual operating hours is expected to be approximately 440 hours per year (approximately 5% of the year) operated to supply electricity at times of high demand. At a 5% usage rate, the expected gas consumption would result in greenhouse gas emissions of 137,614 tonnes CO_2-e and 156,195 tonnes CO_2-e for the Alstom 13E2 and the GE 9FA designs respectively. This is approximately 0.17% and 0.19% of CO_2-e currently emitted by energy production in Victoria (Sustainability Victoria, 2009)

References

Department of Climate Change, 2009. 'National Greenhouse Accounts (NGA) Factors'. Australian Government

Sustainability Victoria, 2009. 'Energy Use in Victoria'. Available at: http://www.sustainability.vic.gov.au/www/html/1819-energy-use-in-victoria.asp. Last accessed 9/7/09

Limitations

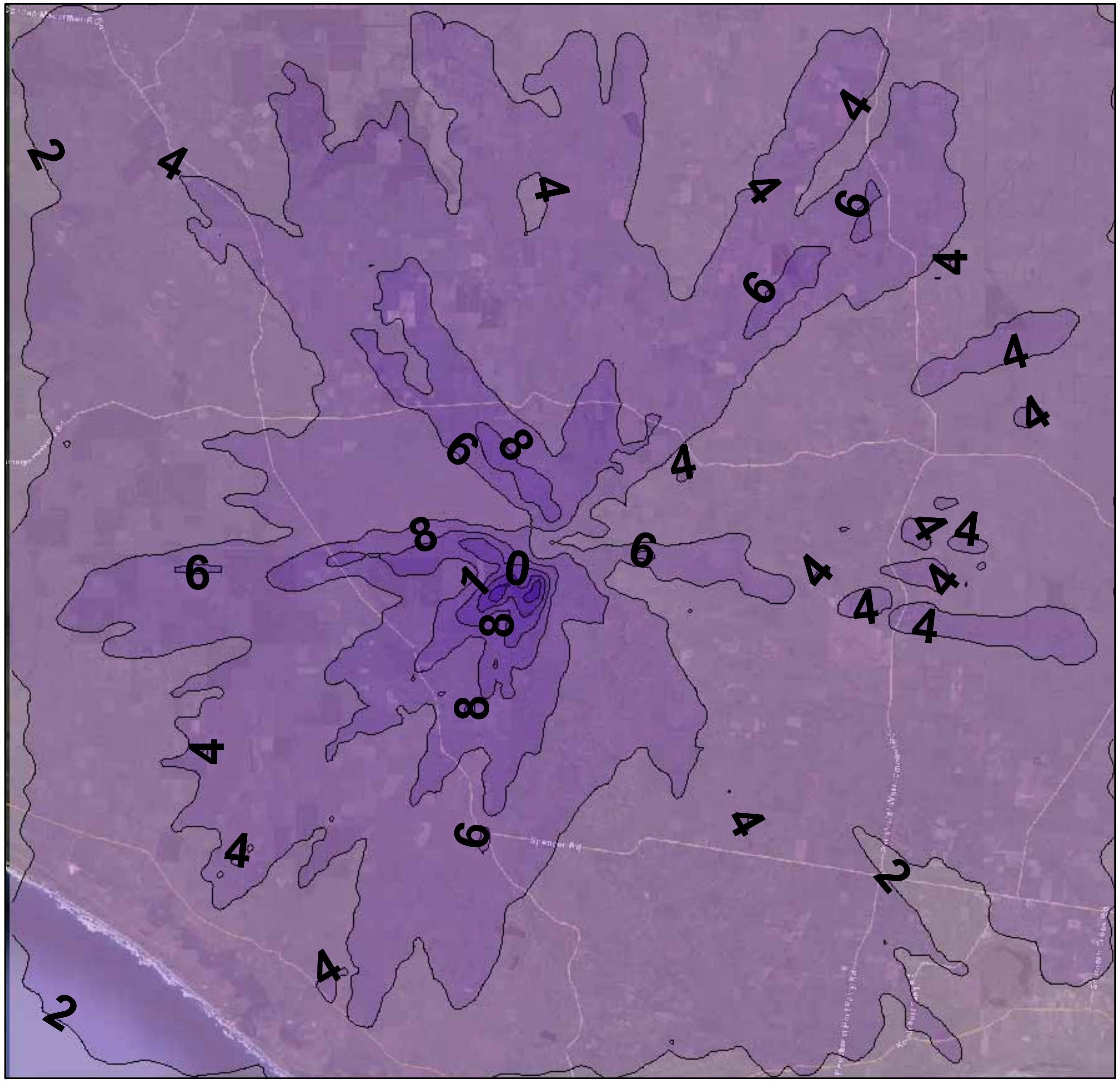
URS Australia Pty Ltd (URS) has prepared this report in accordance with the usual care and thoroughness of the consulting profession for the use of AGL Energy Limited and only those third parties who have been authorised in writing by URS to rely on the report. It is based on generally accepted practices and standards at the time it was prepared. No other warranty, expressed or implied, is made as to the professional advice included in this report. It is prepared in accordance with the scope of work and for the purpose outlined in the Proposal dated 12 September 2008.

The methodology adopted and sources of information used by URS are outlined in this report. URS has made no independent verification of this information beyond the agreed scope of works and URS assumes no responsibility for any inaccuracies or omissions. No indications were found during our investigations that information contained in this report as provided to URS was false.

This report was prepared between March and October 2009 and is based on the conditions encountered and information reviewed at the time of preparation. URS disclaims responsibility for any changes that may have occurred after this time.

This report should be read in full. No responsibility is accepted for use of any part of this report in any other context or for any other purpose or by third parties. This report does not purport to give legal advice. Legal advice can only be given by qualified legal practitioners.

Appendix A Figures



N

NOx as NO2 (ug/m3)

	0 - 2
	3 - 4
	5 - 6
	7 - 8
	9 - 10
	11 - 12
	13 - 14
	15 - 16

SEPP(AQM)
Design Criteria190 ug/m3

0 2.5 5 10 15 20 Kilometers

CLIENT: AGL Energy Limited

PROJECT: AGL Tarrone Peak Loading Power Plant Referal

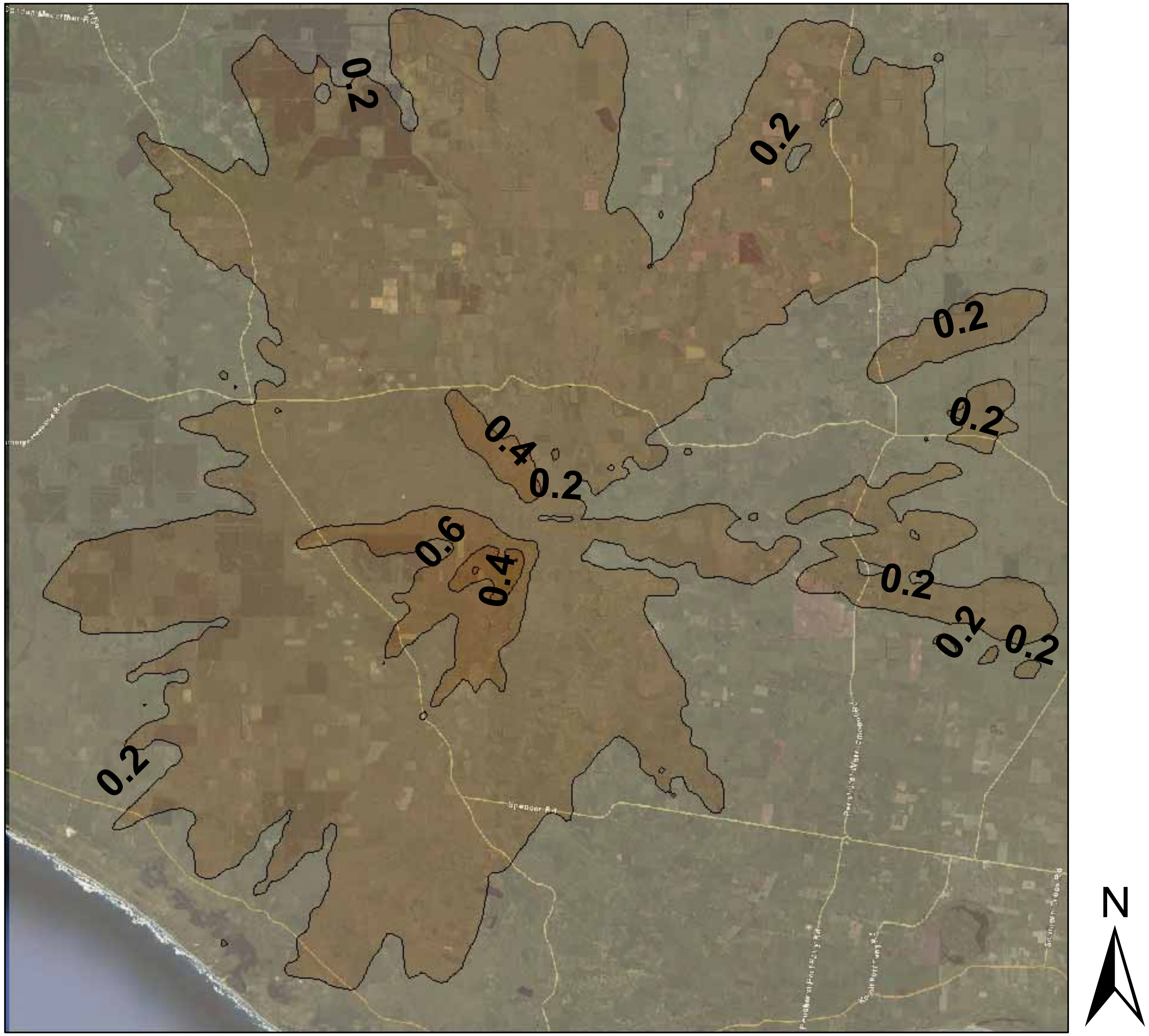
TITLE: Predicted Maximum (99.9th Percentile) 1 hour average NO^x Concentrations (ug/m^3 for Alstom Engine

PROJECT: 43283491

MAP FILE: J:\Jobs\43283491 \WorksI\Air Quality\GIS\ Layouts\AGL_1.mxd

MAP BY: HL
CHECKED BY: IMC
DATE: 12/06/09

Figure:
1



SOx as SO_2 (ug/m^3)

	0.0 - 0.2
	0.3 - 0.4
	0.5 - 0.6
	0.7 - 0.8
	0.9 - 1.0

SEPP(AQM)
Design Criteria 450 ug/m^3

0 2.5 5 10 15 20 Kilometers

CLIENT: AGL Energy Limited

PROJECT: AGL Tarrone Peak Loading Power Plant Referal

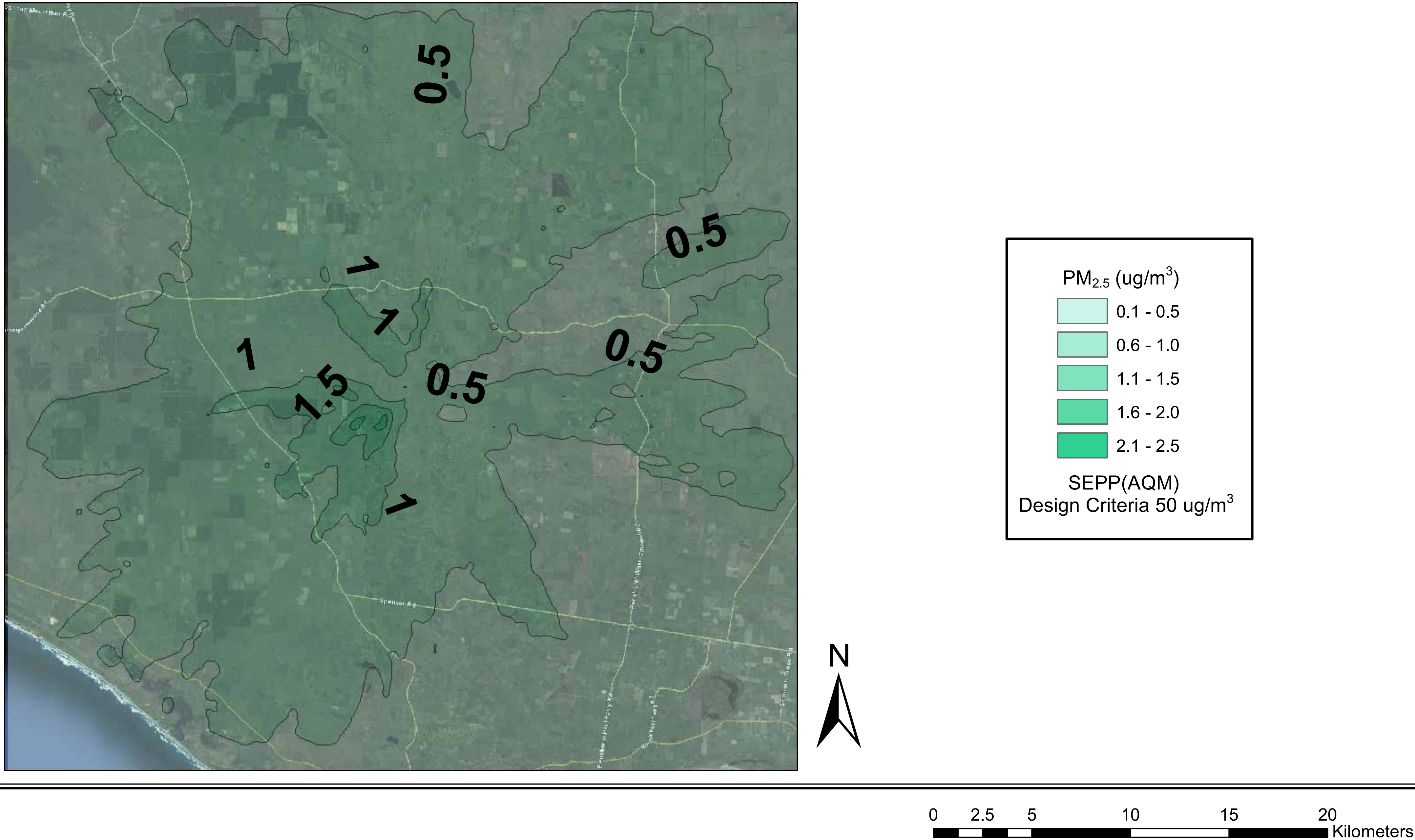
TITLE: Predicted Maximum (99.9th Percentile) 1 hour average SO_x Concentrations (ug/m^3) for Alstom Engine

PROJECT: 43283491

MAP FILE: J:\Jobs\43283491 \WorksI\Air Quality\GIS\ Layouts\AGL_2.mxd

MAP BY: HL
CHECKED BY: IMC
DATE: 12/06/09

Figure: 2



CLIENT: AGL Energy Limited

PROJECT: AGL Tarrone Peak Loading Power Plant Referal

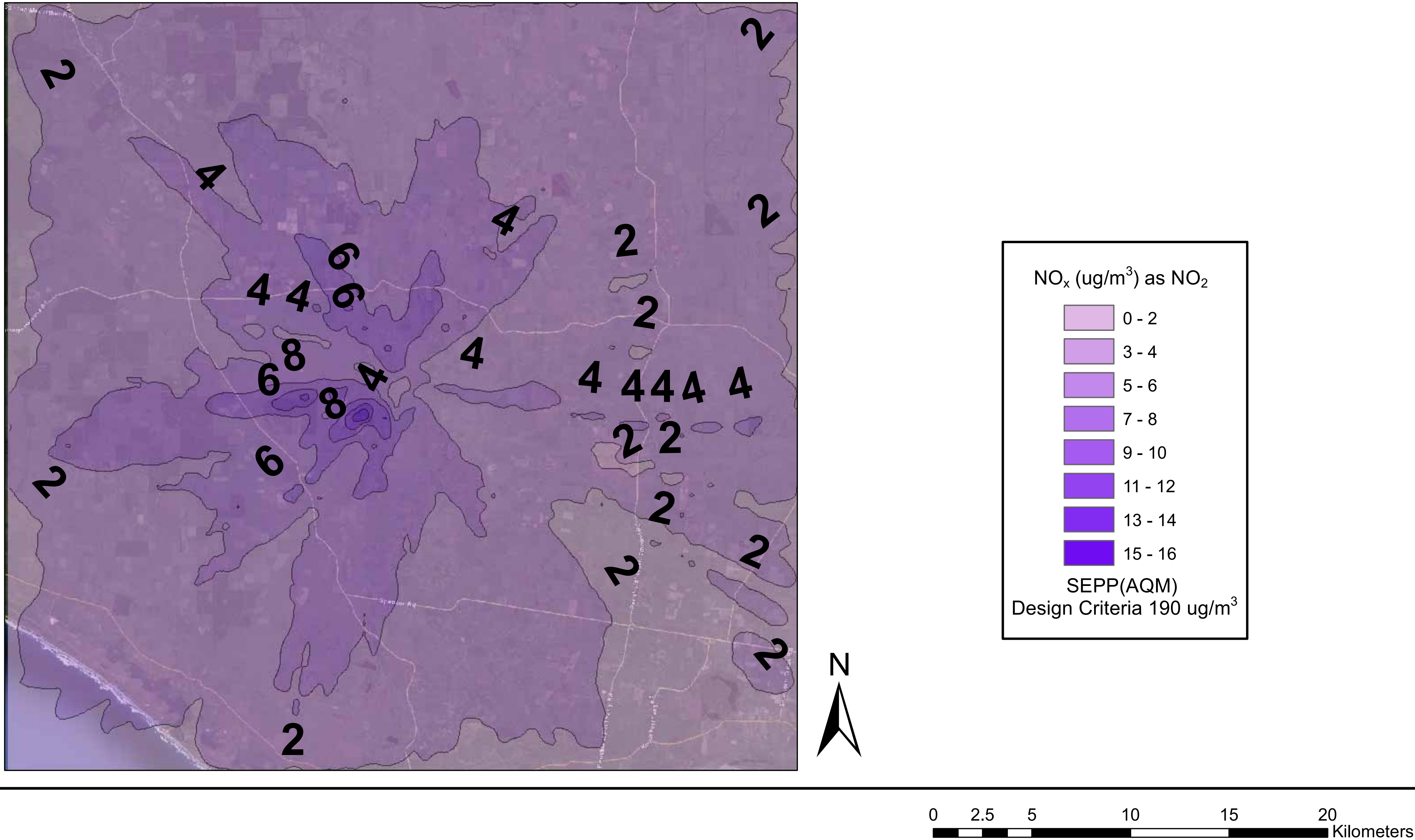
TITLE: Predicted Maximum (99.9th Percentile) 1 hour average $PM_{2.5}$ Concentrations (ug/m^3) for Alstom Engine

PROJECT: 43283491

MAP FILE: J:\Jobs\43283491\Works\Air Quality\GIS\Layouts\AGL_3.mxd

MAP BY: HL
CHECKED BY: IMC
DATE: 12/06/09

Figure: 3



CLIENT: AGL Energy Limited

PROJECT: AGL Tarrone Peak Loading Power Plant Referal

TITLE: Predicted Maximum (99.9th Percentile) 1 hour average NO_x Concentrations (ug/m^3) for GE Engine

PROJECT: 43283491

MAP FILE: J:\Jobs\43283491 \WorksI\Air Quality\GIS\ Layouts\AGL_4.mxd

MAP BY: HL
CHECKED BY: IMC
DATE: 12/06/09

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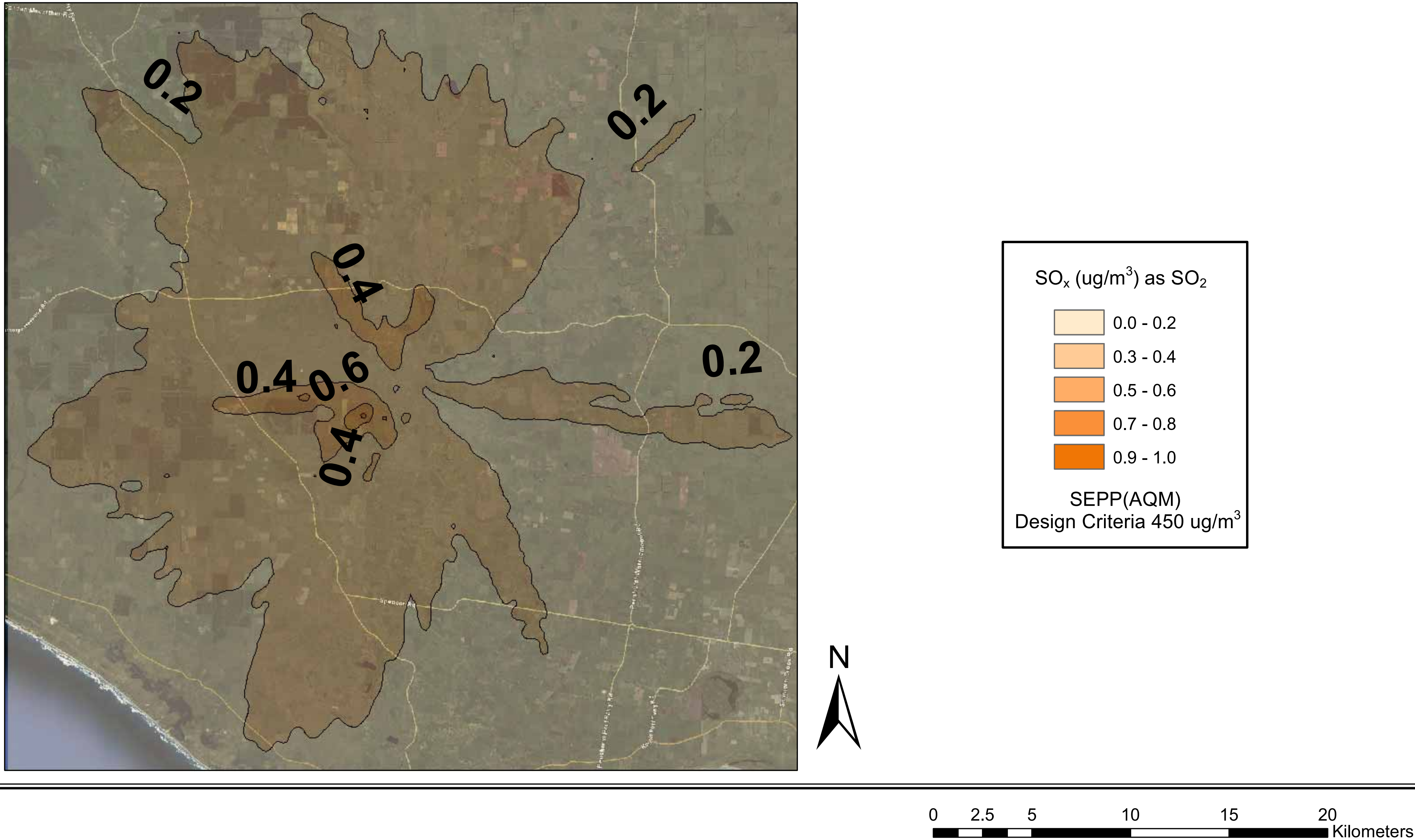
4



CLIENT: AGL Energy Limited

PROJECT: AGL Tarrone Peak Loading Power Plant Referal

TITLE: Predicted Maximum (99.9th Percentile) 1 hour average SO_x Concentrations (ug/m^3) for GE Engine

PROJECT: 43283491 **MAP FILE: J:\Jobs\43283491 \Worksl\Air Quality\GIS\ Layouts\AGL_5.mxd**	**MAP BY: HL** **CHECKED BY: IMC** **DATE: 12/06/09**	**Figure:** 5

CLIENT: AGL Energy Limited

PROJECT: AGL Tarrone Peak Loading Power Plant Referal

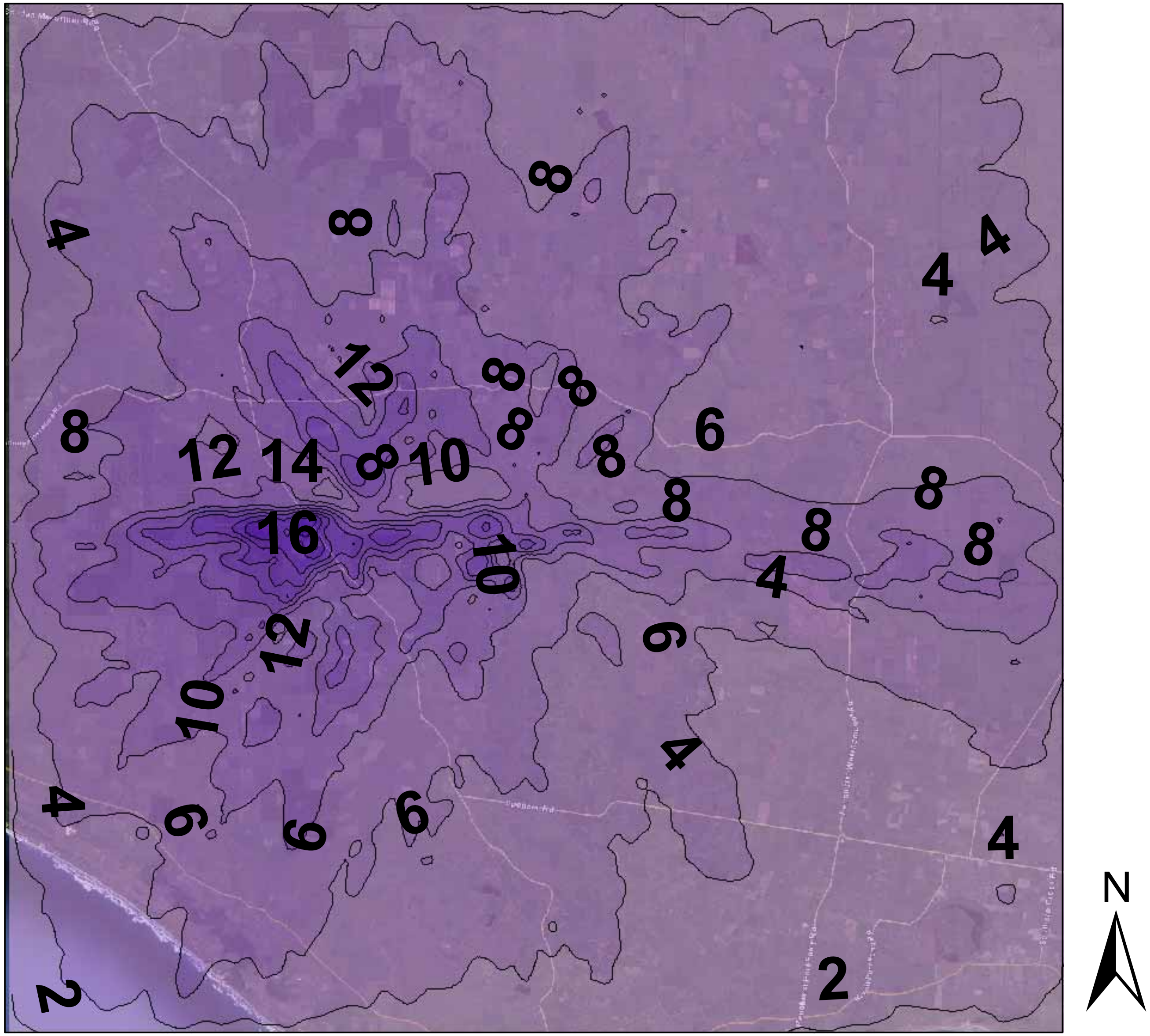
TITLE: Predicted Maximum (99.9th Percentile) 1 hour average $PM_{2.5}$ Concentrations (ug/m^3) for GE Engine

PROJECT: 43283491

MAP FILE: J:\Jobs\43283491 \Works\Air Quality\GIS\ Layouts\AGL_6.mxd

MAP BY: HL
CHECKED BY: IMC
DATE: 12/06/09

Figure:
6



NO_x as NO_2 (ug/m^3)

	0 - 2
	3 - 4
	5 - 6
	7 - 8
	9 - 10
	11 - 12
	13 - 14
	15 - 16
	17 - 18
	19 - 20
	21 - 22
	23 - 24

SEPP(AQM)
Design Criteria 190 ug/m^3

0 2.5 5 10 15 20 Kilometers

CLIENT: **AGL Energy Limited**

PROJECT: **AGL Tarrone Peak Loading Power Plant Referal**

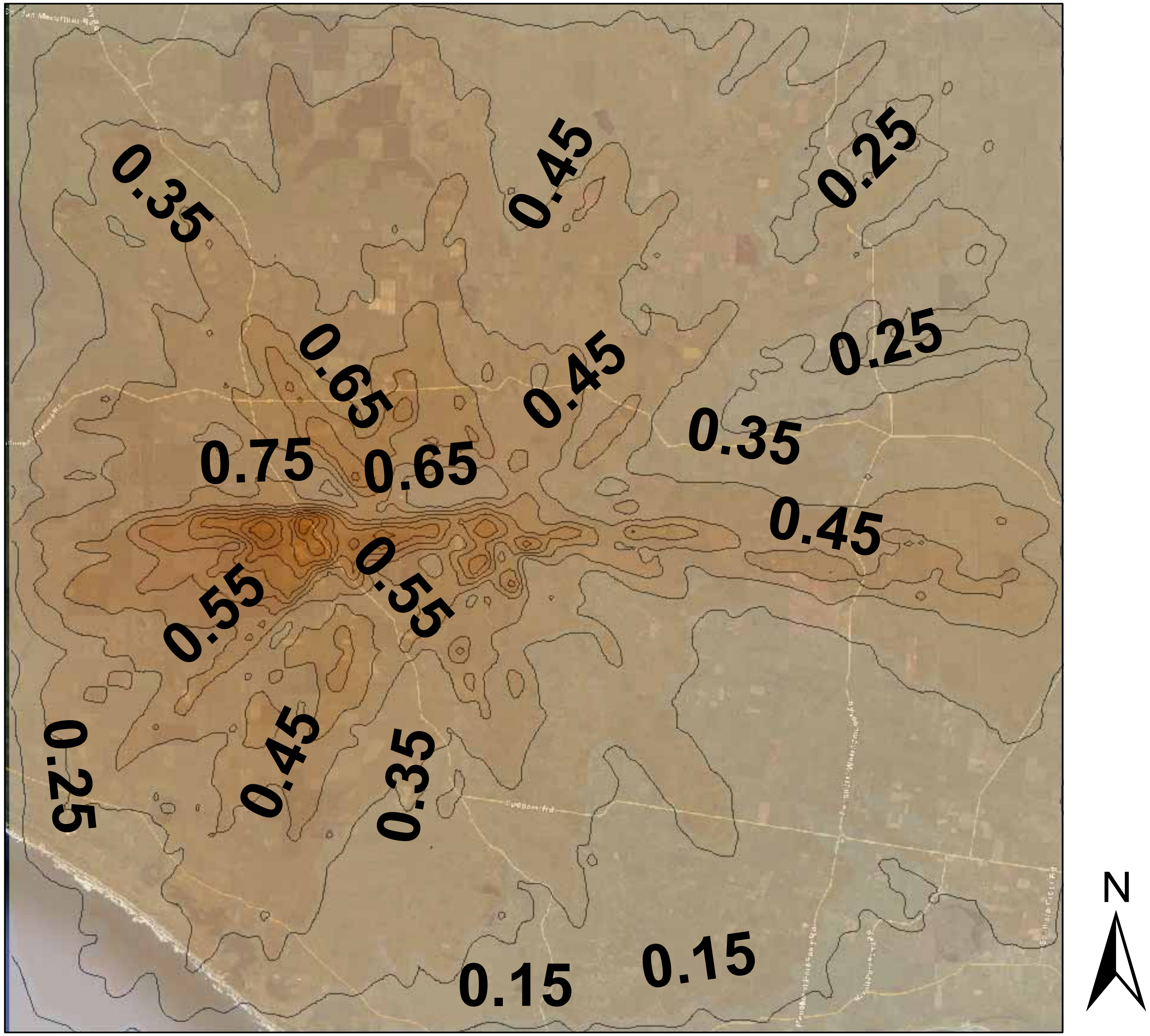
TITLE: **Predicted Maximum (99.9th Percentile) 1 hour average NO_x Concentrations (ug/m^3) for Shaw River and GE Engine**

PROJECT: 43283491

MAP FILE: J:\Jobs\43283491\Worksl\Air Quality\GIS\Layouts\AGL_7.mxd

MAP BY: HL
CHECKED BY: IMC
DATE: 12/06/09

Figure:
7



SO_x as SO_2 (ug/m^3)

	0-0.15
	0.15-0.25
	0.25-0.35
	0.35-0.45
	0.45-0.55
	0.55-0.65
	0.65-0.75
	0.75-0.85
	0.85-0.95
	0.95-1.05
	1.05-1.15
	1.15-1.25
	1.25-1.35

SEPP(AQM)
Design Criteria 450 ug/m^3

0 2.5 5 10 15 20 Kilometers

CLIENT: AGL Energy Limited

PROJECT: AGL Tarrone Peak Loading Power Plant Referal

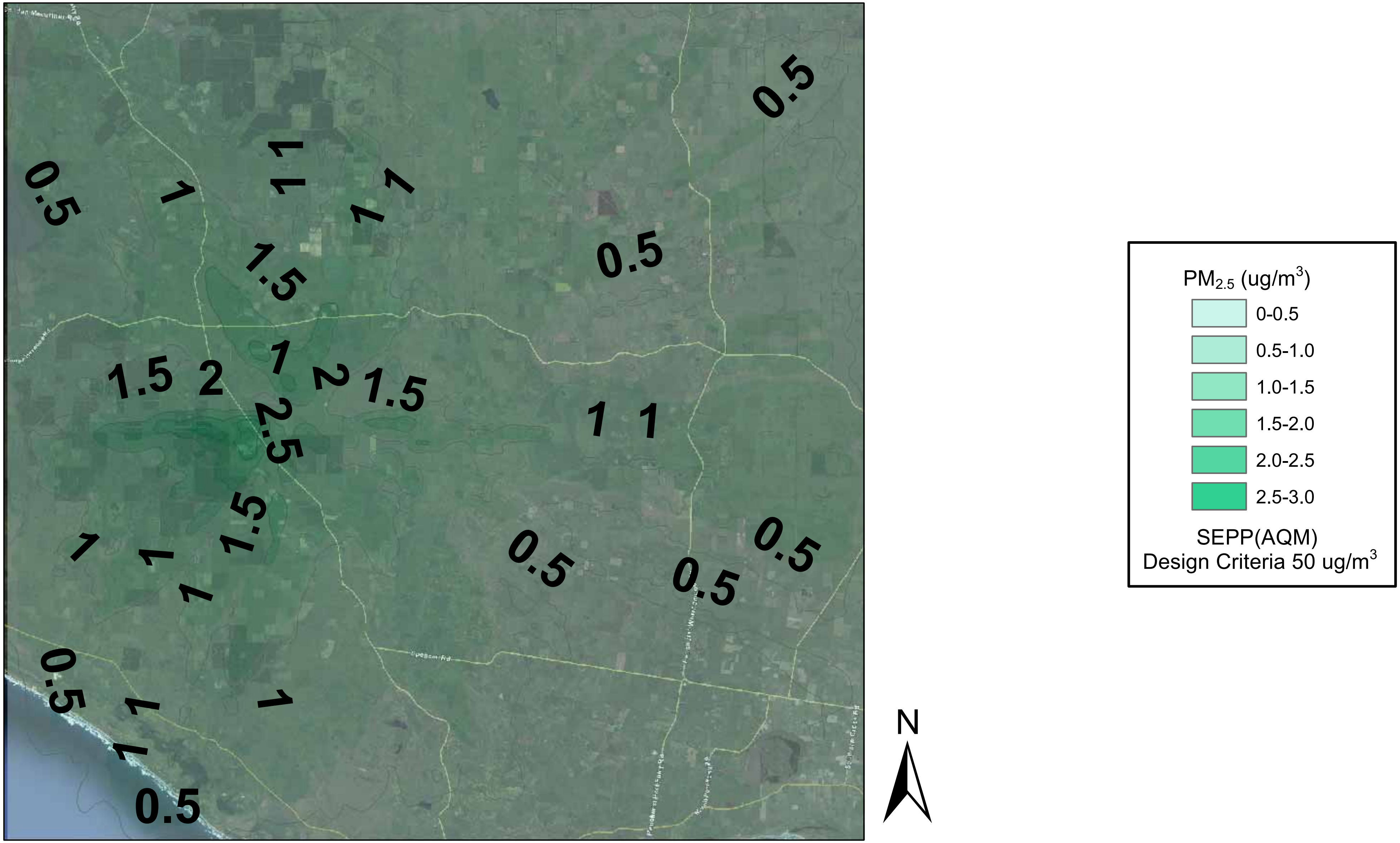
TITLE: Predicted Maximum (99.9th Percentile) 1 hour average SO_x Concentrations (ug/m^3) for Shaw River and GE Engine

PROJECT: 43283491

MAP FILE: J:\Jobs\43283491 \WorksI\Air Quality\GIS\ Layouts\AGL_8.mxd

MAP BY: HL
CHECKED BY: IMC
DATE: 12/06/09

Figure: 8



0 2.5 5 10 15 20 Kilometers

CLIENT: AGL Energy Limited

PROJECT: AGL Tarrone Peak Loading Power Plant Referal

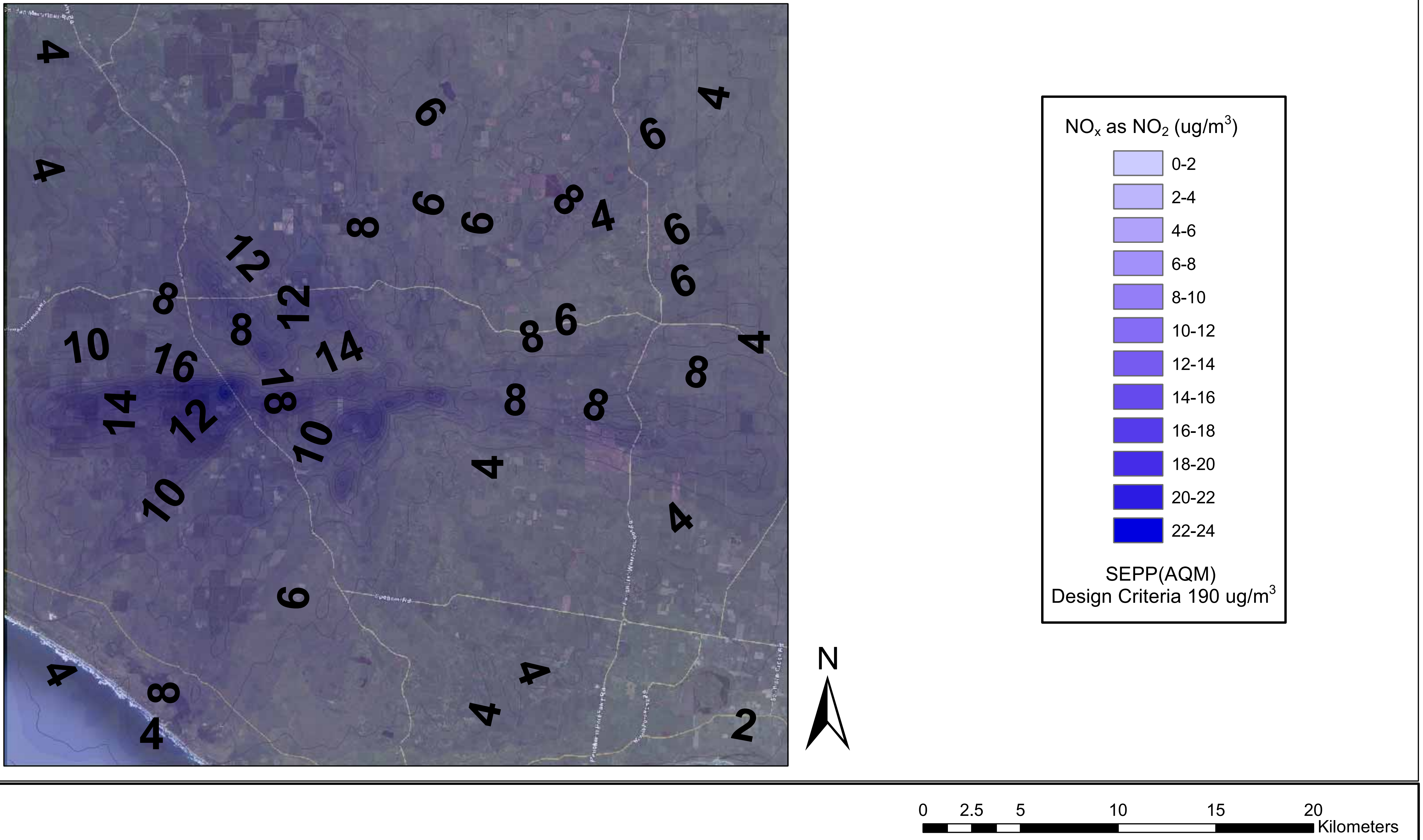
TITLE: Predicted Maximum (99.9th Percentile) 1 hour average $PM_{2.5}$ Concentrations (ug/m^3) for Shaw River and GE Engine

PROJECT: 43283491

MAP FILE: J:\Jobs\43283491 \WorksI\Air Quality\GIS\ Layouts\AGL_9.mxd

MAP BY: HL
CHECKED BY: IMC
DATE: 12/06/09

Figure: 9



CLIENT: AGL Energy Limited

PROJECT: AGL Tarrone Peak Loading Power Plant Referal

TITLE: Predicted Maximum (99.9th Percentile) 1 hour average NO_x Concentrations (ug/m^3) for Shaw River and Alstom Engine

PROJECT: 43283491

MAP FILE: J:\Jobs\43283491 \Works\Air Quality\GIS\ Layouts\AGL_10.mxd

MAP BY: HL
CHECKED BY: IMC
DATE: 12/06/09

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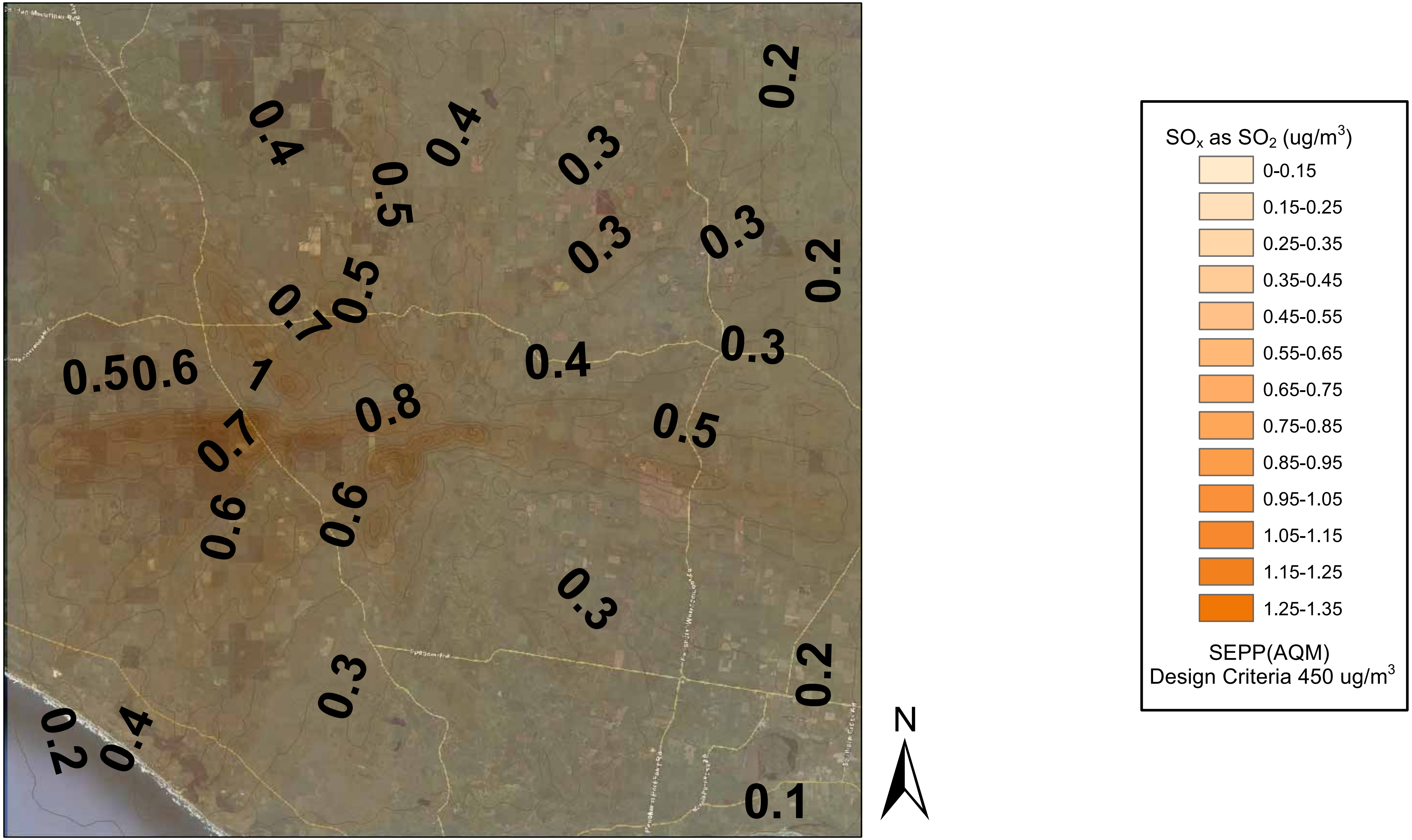


0 2.5 5 10 15 20 Kilometers

CLIENT: AGL Energy Limited

PROJECT: AGL Tarrone Peak Loading Power Plant Referal

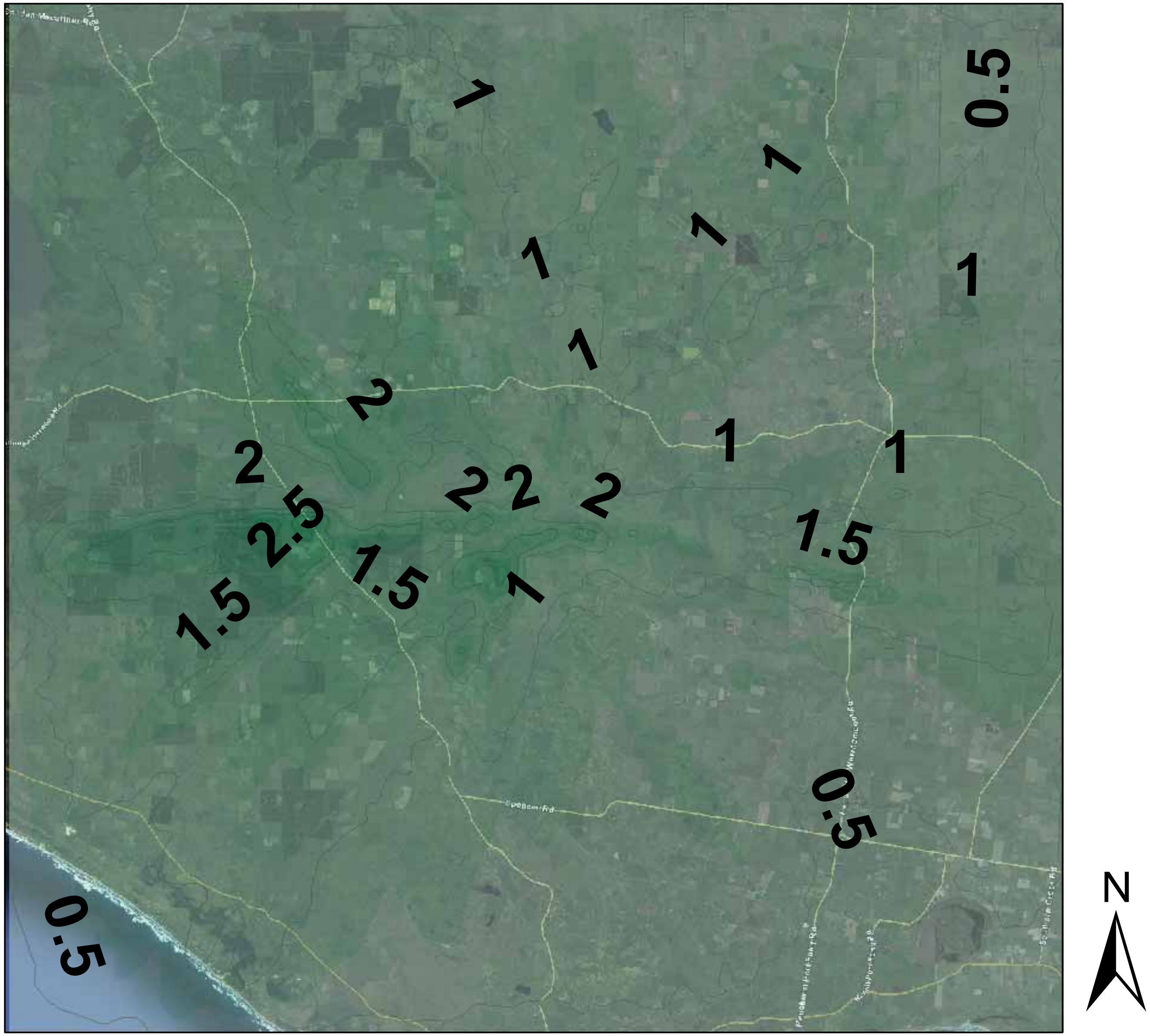
TITLE: Predicted Maximum (99.9th Percentile) 1 hour average SO$_x$ Concentrations (ug/m^3) for Shaw River and Alstom Engine

PROJECT: 43283491

MAP FILE: J:\Jobs\43283491 \WorksI\Air Quality\GIS\ Layouts\AGL_11.mxd

MAP BY: HL
CHECKED BY: IMC
DATE: 12/06/09

Figure: 11



PM2.5 (ug/m^3)

- 0-0.5
- 0.5-1.0
- 1.0-1.5
- 1.5-2.0
- 2.0-2.5
- 2.5-3.0

SEPP(AQM)
Design Criteria 50 ug/m^3

0 2.5 5 10 15 20 Kilometers

CLIENT: AGL Energy Limited

PROJECT: AGL Tarrone Peak Loading Power Plant Referal

TITLE: Predicted Maximum (99.9th Percentile) 1 hour average $PM_{2.5}$ Concentrations (ug/m^3) for Shaw River and Alstom Engine

PROJECT: 43283491

MAP FILE: J:\Jobs\43283491\Works\Air Quality\GIS\Layouts\AGL_12.mxd

MAP BY: HL
CHECKED BY: IMC
DATE: 12/06/09

Figure: 12

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