AIR QUALITY IMPACT ASSESSMENT

LUCAS HEIGHTS ALTERNATIVE WASTE TECHNOLOGY FACILITY

WSN Environmental Solutions

Job No: 2890A

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A PEL Company

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1 INTRODUCTION

This report has been prepared by PAEHolmes (formerly Holmes Air Sciences) for WSN Environmental Solutions (WSN) who propose to construct and operate an Alternative Waste Technology (AWT) facility at Lucas Heights Waste and Recycling Centre (LHWRC). The report forms part of the Environmental Assessment (EA) for the project. The proposed site is adjacent to the existing Lucas Heights landfill operation as shown in **Figure 1.1**.

The purpose of this air quality report is to quantitatively assess potential air quality including odour impacts that may arise due to the operation of the proposed AWT. Cumulative impacts of the AWT operation and the landfill site have also been assessed. Air toxics, pathogens and dust during construction have been assessed qualitatively. The term "air quality" is a collective term which refers to all of these things which have the potential to affect the health and amenity of workers and the general public.

This air quality assessment is based on the use of a computer-based dispersion model, CALPUFF, to predict off-site odour levels. To assess the effect that potential emissions could have on existing air quality, the dispersion model predictions have been compared to relevant regulatory air quality criteria.

The assessment is based on a conventional approach following the procedures outlined in the NSW Department of Environment and Climate Change's (DECC) document titled "Approved Methods and Guidance for the Modelling and Assessment of Air Pollutants in NSW" (**DEC, 2005**).

In summary, this report provides information on the following:

- summary of operations;
- summary of air quality criteria;
- meteorological conditions in the area;
- emission sources and estimates of these emissions;
- methods used to predict off-site impact levels from expected emissions from the site; and
- expected dispersion patterns and predicted impacts.

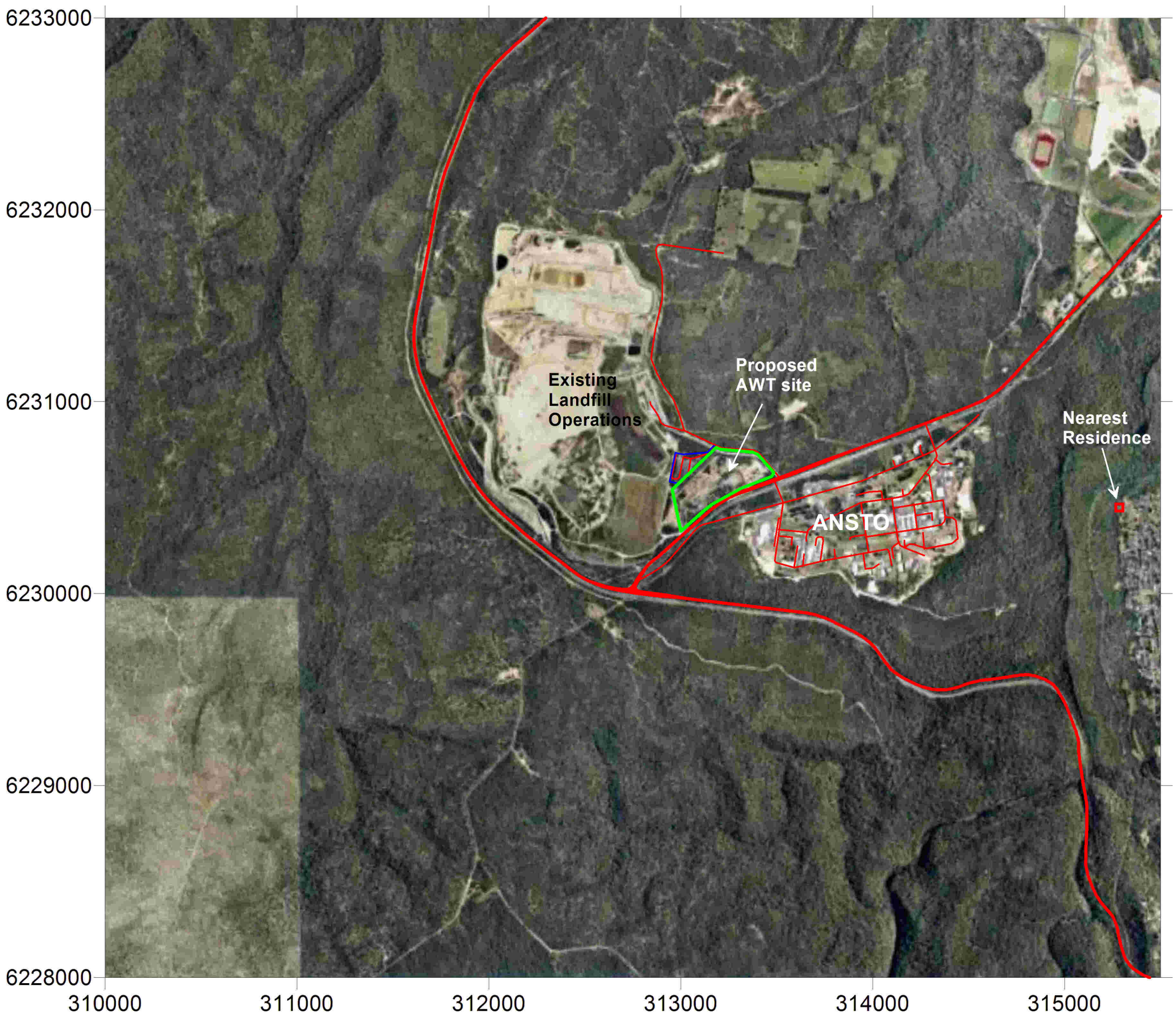


Figure 1.1: Location of existing landfill and proposed AWT sites

2 PROJECT DESCRIPTION

The AWT facility is to be located adjacent to the southeastern boundary of the current Lucas Heights landfill operations as shown in **Figure 1.1**. **Figure 2.1** shows the proposed layout for the AWT site.

The proposed AWT Facility would include a mechanical biological treatment (MBT) plant to process up to 100,000 tonnes per year of mixed municipal solid waste (MSW) using the patented ArrowBio technology. The ArrowBio process consists of anaerobic treatment of the organic waste to produce biogas for electricity production. The MBT technology is similar to that currently commissioned at WSN's Jacks Gully site (the Macarthur Resource Recovery Park) in south west Sydney and would incorporate the following:

- Receival hall;
- Processing building;
- Biological plant;
- Energy generation plant;
- Waste water treatment plant (WWTP);
- Sludge dewatering area;
- Staff facilities;
- Parking area; and
- Internal road network.

The air emissions assessed in this report are;

- odour from;
  - the receival and processing halls;
  - the open tanks at the WWTP;
  - the sludge dewatering area;
  - periodic cleaning of the acetogenic tanks;
- oxides of nitrogen (NO_x) from
  - the proposed biogas engines; and
- dust from
  - the construction and operational phase.

It is proposed for a truck parking area to be constructed adjacent to the southwestern boundary of the AWT to accommodate waste collection trucks overnight. This proposal is part of a separate Development Application to the AWT but is being considered from a cumulative impact perspective. There may be some additional odour from these trucks but is not considered to be a significant source in relation to the AWT itself and indeed the landfilling and greenwaste operations. As such, it has not been incorporated in the modelling.

There will also be some dust associated with the construction of the truck parking area, but as shown in an assessment carried out for that operation (**PAEHolmes, 2009**), these emissions are not considered to be significant and have not been included in the modelling. It may be possible to ensure that the construction at the two sites do not occur at the same time in order to keep emissions to a minimum.

Any potential dust emissions from the PCYC activities have not been included in the modelling, as they are existing activities and will have been captured in the onsite dust monitoring, both deposition and concentration. The monitoring data were summarised a report assessing the impacts of modifications to the conditions of consent (**PAEHolmes, 2009**). These data showed that measured levels, which include activities at the PCYC, are well below the DECC criteria.

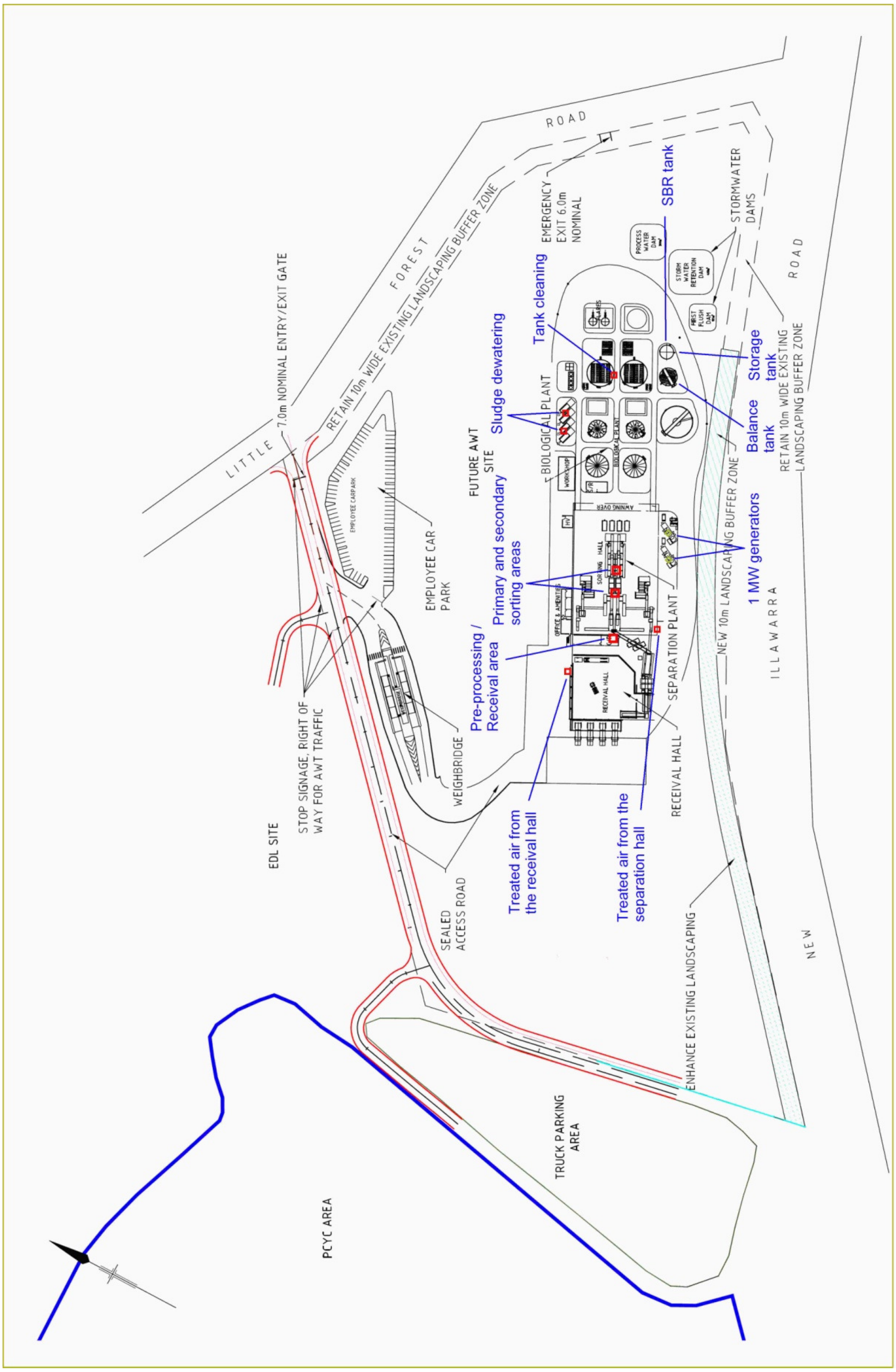


Figure 2.1: Site layout and source locations

3 AIR QUALITY ISSUES

3.1 Odour

The proposed AWT facility will be a potential source of odour emissions. This section discusses the measurement and air quality criteria that relate to odour.

Odour is measured using panels of people who are presented with samples of odorous gas diluted with decreasing quantities of clean odour-free air. The panellists then note when the smell becomes detectable. Odour in the air is then quantified in terms of odour units which is the number of dilutions required to bring the odour to a level at which 50% of the panellists can just detect the odour, defined as one odour unit. This process is known as olfactometry.

Olfactometry can involve a "forced-choice" end point or a "free choice" endpoint. The "forced-choice" method is where panellists identify from multiple sniffing ports, the one port where odour is detected, regardless of whether they are sure they can detect odour. The "free choice" endpoint is a "yes/no" decision where panellists are required to say whether or not they can detect odour from one sniffing port. Forced-choice olfactometry generally detects lower odour levels than free choice olfactometry.

In both the "forced-choice" and "free choice" cases, odorous air is presented to the panellists in increasing concentrations. For the forced-choice method, where there are multiple ports for each panellist, the concentration is increased until all panellists consistently distinguish the port with the sample from the blanks. For a yes/no olfactometer (which has only one sniffing port) one method used is to increase the concentration of odour in the sample until all panellists respond. The sample is then shut off and once all panellists cease to respond, the sample is introduced again at random dilutions and the panellists are asked whether they can detect the odour.

An Australian Standard (AS/NZS 4323.3.2001) for olfactometry has been developed which is consistent with the European Standard, CEN. These standards have adopted the certainty threshold as the odour standard and referencing this to a concentration of butanol (40 ppb). The odour levels referred to in this report are the certainty odour levels.

As with all sensory methods of identification there is variability between individuals. Consequently the results of odour measurements depend on the way in which the panel is selected and the way in which the panel responses are interpreted. The process by which these imprecise measurements are translated into regulatory criteria is outlined in the recently published DECC Technical Framework for assessment and management of odour (**DEC 2006a and 2006b**).

3.1.1 Odour criteria

The DECC has in recent times refined odour criteria and the way in which they should be applied with dispersion models to assess the likelihood of nuisance impact arising from the emission of odour.

Odour impacts are determined by several factors, the most important of which are:

- the **F**requency of the exposure;
- the **I**ntensity of the odour;
- the **D**uration of the odour episodes;
- the **O**ffensiveness of the odour; and
- the **L**ocation of the source (the so-called FIDOL factor).

In determining the offensiveness of an odour it needs to be recognised that for most odours the context in which an odour is perceived is also relevant. Some odours, for example the smell of sewage, hydrogen sulfide, butyric acid, landfill gas etc., are likely to be judged offensive regardless of the context in which they occur. Other odours such as the smell of jet fuel may be acceptable at an airport, but not in a house, and diesel exhaust may be acceptable near a busy road, but not in a restaurant.

In summary, whether or not an individual considers an odour to be a nuisance will depend on the FIDOL factors outlined above and although it is possible to derive formulae for assessing odour annoyance in a community, the response of any individual to an odour is still unpredictable. Odour goals need to take account of these factors.

The NSW DECC framework documents include some recommendations for odour criteria. They have been refined by the DECC to take account of population density in the area. **Table 3.1** lists the odour certainty[a] thresholds, to be exceeded not more than 1% of the time, for different population densities.

Table 3.1: Odour performance criteria for the assessment of odour

Population of affected community	Odour performance criteria (nose response odour certainty units at the 99th percentile)
Single residence (≤ ~ 2)	7
~ 10	6
~ 30	5
~ 125	4
~ 150	3
Urban (~ 2000)	2

[a] *In the process of odour measurement, the odour certainty threshold is, by definition, the minimum concentration at which the panellist is certain they can detect the odour.*

The difference between odour criteria is based on considerations of risk of odour impact rather than differences in odour acceptability between urban and rural areas. For a given odour level there will be a wide range of responses in the population exposed to the odour. In a densely populated area there will therefore be a greater risk that some individuals within the community will find the odour unacceptable than in a sparsely populated area.

The criteria assume that 7 odour units at the 99^{th} percentile would be acceptable to the average person, but as the number of exposed people increases there is a chance that sensitive individuals would be exposed. The criterion of 2 odour units at the 99^{th} percentile is considered to be acceptable for the whole population.

The area immediately surrounding the site contains developments such as the landfill area to the northwest and the Lucas Heights Nuclear Facility operated by the Australian Nuclear Science and Technology Organisation (ANSTO), to the southeast. These facilities are surrounded primarily by bushland with the nearest residence approximately 2 km away (as shown in **Figure 1**). The population density in those residential areas are such that they are considered an urban environment for assessment purposes (as described in **Table 3.1**) and as there are other odorous industries in the area there is the potential for a cumulative impact. On this basis, the most stringent odour criterion of 2 ou has been applied to the project.

It is common practice to use dispersion models to determine compliance with odour criteria. This introduces a complication because Gaussian dispersion models are only able to directly predict concentrations over an averaging period of three-minutes or greater. The human nose, however, responds to odours over periods of the order of a second or so. During a three-minute period, odour levels can fluctuate significantly above and below the mean depending on the nature of the source.

To determine more rigorously the ratio between the one-second peak concentrations and three-minute and longer period average concentrations (referred to as the peak to mean ratio) that might be predicted by a Gaussian dispersion model, the NSW DECC commissioned a study by **Katestone Scientific Pty Ltd (1998)**. This study recommended peak to mean ratios for a range of source types. The ratio is also dependent on atmospheric stability and the distance from the source. A summary table of these ratios is presented in **Appendix A.**

The DECC *Technical Framework for odour assessment* (**DEC, 2006a** and **2006b**) and *Approved Methods for the Modelling and Assessment of Air Pollutants in NSW* (**DEC, 2005**) take account of this peaking factor and the criteria shown in **Table 3.1** are based on nose-response time.

3.2 Oxides of nitrogen

Oxides of nitrogen are produced when air is oxidised at high temperature and pressure during combustion. Nitrogen oxides (NO_x) are comprised mainly of nitric oxide (NO) and nitrogen dioxide (NO_2). At the point of emission the proportion of NO is much greater than that of NO_2 but as time progresses the NO is converted to NO_2. Nitric oxide is much less harmful to humans than nitrogen dioxide and is not generally considered a pollutant at the concentrations normally found in urban environments.

Table 3.2 lists the air quality goals for nitrogen dioxide noted by the DECC (**DEC, 2005**) and National Environment Protection Measures (NEPM). Nitrogen dioxide is assessed in this report as it is a product of the combustion of biogas. The primary air quality objective is to ensure that the air quality goals are not exceeded at any location where there is a possibility of human exposure.

Table 3.2: Air quality goals for nitrogen dioxide

Criterion	Average Period	Agency
0.12 ppm or 246 $\mu g/m^3$	1-hour maximum	NSW DECC, NEPM
0.03 ppm or 62 $\mu g/m^3$	Annual mean	NSW DECC, NEPM

3.3 Dust

There is potential for dust emissions during the construction and operational phases of the project. Dust during construction would be managed via a Construction Environmental Management Plan (EMP), and during operation via an Operational EMP. Recommendations for this plan are listed in **Section 8**. The nearest residences are at such distances (approximately 2 km) that it is unlikely that there would be any adverse impacts from dust during construction.

There is also potential for dust emissions from the waste material during unloading and sorting. This can be controlled through water sprays within the receival hall and is unlikely to be a significant source of off-site emissions. The receival hall is also enclosed which will cause operational dust emissions from this area to be almost negligible.

There is the potential for dust in the workplace to be inhaled by workers and cause respiratory problems. The recommended maximum exposure level for dust is 10 mg/m^3 time weighted average (TWA) measured as inspriable dust over an 8-hour day, 5-day working week (**NOHSC, 1995**). This is for unclassified dust with no specified toxic components.

Measurements undertaken on two weeks over an 8-hour shift by Hibbs and Associates **(GHD, 2006)** at the Jacks Gully site (the Macarthur Resource Recovery Park) existing materials recovery facility indicated dust levels of 1.4 and 1.5 mg/m^3, well below occupational health criteria of 10 mg/m^3. Operations at the Lucas Heights AWT will be similar and therefore levels are expected to be similar.

3.4 Air toxics and pathogens

The received material will be municipal waste and will not contain any substantial quantities of potentially toxic chemicals such as could be present in industrial waste. The level of carcinogenic or other toxic emissions would therefore be extremely low. However as there will be putrescible material processed through biological treatment, there is potential for emissions of pathogenic organisms.

As the AWT facility will not be accessible to the general public, the main health issue relates to exposure of workers to health risks associated with the operation of the facility.

While there is potential for staff working at the facility to come into contact with pathogens in the material and those formed during the wastewater treatment process, the level of hazard would not be significantly different from those in existing facilities operated by WSN, for example transfer stations, material recovery facilities and for wastewater treatment plants. There is no evidence to suggest that this poses an unacceptable risk in the workplace provided normal precautions are taken. These precautions would include normal industrial hygiene procedures such as washing hands before eating and smoking.

4 EXISTING ENVIRONMENT

4.1 Dispersion meteorology

The model used for this assessment, CALPUFF, requires information on the dispersion characteristics for the area.

A wind field has been generated by CALMET for each hour of the calendar year 1st July 2001 to 30th June 2002 using the surface wind data collected from the Lucas Heights automatic weather station (AWS). The CALMET model has essentially used the data from this site to determine wind patterns over the entire modelling domain given information on the local landuse and terrain features. Upper air information was derived from CSIRO's prognostic model (The Air Pollution Model, TAPM).

Windroses prepared from that data are shown in **Figure 4.1**. On an annual basis the winds are predominantly from the southwest and southeast. The south easterlies are present in summer and autumn and the south westerlies are present in winter. Winds occur from most directions in spring.

Additional meteorological data have been obtained from WSN. These data consist of 15-minute averages for the period March 2007 to February 2008 and have been used to compile the windroses shown in **Figure 4.2**. There are a few differences between the two data sets, most noticeably the dominance of winds from the south-southeast in all seasons except winter. Winds during winter are very similar to the 2001 windroses in **Figure 4.1**, being predominantly from the southwestern quadrant.

The 2001/2002 data set used in this assessment (represented in **Figure 4.1**) are likely to be more conservative as they show a higher percentage of winds from the southwest which would blow from the AWT towards the residential areas.

A summary of the data and parameters used as part of the meteorological component of this study are shown in **Table 4.1**.

Table 4.1: Summary of the CALMET parameters used

Parameter	Value
Meteorological grid origin	310.000, 6228.000 (MGA coordinates)
Meteorological grid domain	4 km x 4 km
Meteorological grid resolution	0.1 km (100 m)
Surface meteorological station	Lucas Heights 2001/2002
Upper air meteorological station	Lucas Heights using data generated by TAPM
Simulation length	8784 hours

Figure 4.1: Annual and seasonal windroses for Lucas Heights 2001

Figure 4.2: Annual and seasonal windroses for Lucas Heights 2007/2008

4.2 Existing NO_2 levels

In order to determine the current levels of NO_2 in the Lucas Heights area it is necessary to examine local monitoring data. The DECC have a number of monitoring sites in their metropolitan network, but unfortunately there are none in the immediate vicinity of the Lucas Heights facility. The nearest sites are located at Liverpool (to the north-northwest) and Campbelltown / Macarthur (to the west), both between 15 – 20 km away from the study area. NO_2 data for these sites is summarised in **Table 4.2**. There were a substantial amount of missing data for the Campbelltown site, but those that were available are listed in **Table 4.2**.

Table 4.2: Summary of NO_2 monitoring data from 2000 to 2006

Year	Liverpool		Campbelltown / Macarthur[b]	
	Maximum 1-hour average (µg/m^3)	Annual average (µg/m^3)	Maximum 1-hour average (µg/m^3)	Annual average (µg/m^3)
DECC Goal	*246*	*62*	*246*	*62*
2000	162	29	154	ND
2001	137	29	146	ND
2002	139	31	ND	ND
2003	131	27	ND	ND
2004	123	27	ND	ND
2005	129	27	166	25
2006	109	37	135	25

ND = No data available

The highest annual average NO_2 value was 37 µg/m^3, measured at Liverpool in 2006, which is well below the goal of 62 µg/m^3. The highest 1-hour value was 166 µg/m^3 at Macarthur in 2005, which is also well below the relevant air quality goal of 246 µg/m^3. It has been assumed that these values are representative of the study area and they have been used as conservative background levels in the assessment in **Section 7**.

[b] *The Campbelltown station was decommissioned in October 2004 and the Macarthur station began monitoring at that time. Both sites are very close to each other and measurements from one site can be considered representative of the other. Entries in this table prior to 2005 are from Campbelltown, while those for 2005 and 2006 are from Macarthur.*

5 ESTIMATED EMISSIONS

5.1 Odour

There are two main sources of odour in the area of the proposed AWT facility. These are the AWT facility itself and the landfill site to the northwest (including a greenwaste and composting facility), shown in **Figure 1.1**. These sources have been assessed individually, to show the relative contributions from each operation, and combined for a cumulative assessment.

Odour emission rates from different parts of the landfill and AWT site are summarised in **Table 5.1**. The main sources of odour from the AWT will be:

- treated air from the receival and processing hall;
- exposed tank areas at the waste water treatment plant; and
- the sludge dewatering area.

There will also be odour, on occasion, when the acetogenic tanks are cleaned once every 2 to 3 years and a side panel is removed to allow cleaning equipment into the tank.

Air from the receival and process halls will be treated to reduce odour. The likely method of odour control will be an ozone injection system to reduce odours from the air before being discharged to the atmosphere through a vent on the side of each building at an airflow rate of 14,160 L/s or 14.16m^3/s. It has been assumed for the purposes of this assessment that the concentration of odour in the air after treatment will be of the order of 150 ou, which corresponds to an emissions rate of 2,124 ou.m^3/s from each vent as listed in **Table 5.1**.

A conservative assessment has been achieved by assuming some additional odour emissions from the pre-processing area, and the sorting pools to account for times when doors may be opened or damaged. This will not happen all the time so the assumption is conservative.

The pre-processing area refers to the area inside the receival hall where material is being conveyed and sorted by hand. The primary and secondary sorting pools are inside the processing building where the raw material is wet and further sorting takes place. The locations of these sources, for modelling purposes, are shown in **Figure 2.1**.

Table 5.1: Estimated odour emission rates for each site

Source	Emission rate ($ou.m^3/m^2/s$)	Area (m^2)	Total emissions ($ou.m^3/s$)
Proposed AWT facility			
Balance tank at WWTP[c]	0.1	150	15
Storage tank at WWTP[c]	0.1	30	3
SBR tank at WWTP[d]	0.4	55	22
Dewatered sludge[e]	0.5	2	1
Pre-processing/Receival area[f]	5.0	64	320
Primary sorting pool[g]	1.0	16	16
Secondary sorting pool[g]	1.0	36	36
Acetogenic tank cleaning[f]	5.0	4	20
Treated air vents			
Source	**Odour concentration (ou)**	**Flow rate (m^3/s)**	**Total emissions ($ou.m^3/s$)**
Treated air from the receival hall	150	14.16	2,124
Treated air from the process building	150	14.16	2,214
Landfill site[h]			
Source	**Emission rate ($ou.m^3/m^2/s$)**	**Area (m^2)**	**Total emissions ($ou.m^3/s$)**
Greenwaste	0.238	18,700	4,450
Greenwaste dam	0.145	2,100	305
Greenwaste windrows	0.238	33,100	7,880
Intermediate cover	0.084	172,000	14,450
Leachate area 1	0.2	1,000	200
Leachate area 2	0.28	1,300	364
Area 4	0.91	30,000	27,300
Active tipping face	2.05	11,800	24,200
Greenwaste stockpile	0.164	7,500	1,230

[c] *These values were based on emission factors for clarifiers at various WWTPs, as there were no available emission rate data for these specific sources.*

[d] *This value was based on about half the emissions for aeration tanks at various WWTPs, as there were no available data for these emission rates.*

[e] *These values were based on emission factors for sludge dewatering at various WWTPs, as there were no available data for these emission rates.*

[f] *This value was based on reduced emission factors for inlet works at various WWTPs. In reality, it is likely that the emissions will be lower and more in line with those from the active tipping face at the landfill site. However, as will be shown in* ***Section 7****, the odour concentrations off-site are not predicted to cause any adverse impacts at nearby residences even with these conservative emission estimates.*

[g] *These values were based on GHD emission factors for aeration tanks at various WWTPs, as there were no available data for these emission rates.*

[h] *Based on measurements from an odour audit at the site (****Holmes Air Sciences, 2006a****).*

5.2 Nitrogen dioxide

It is proposed that the biogas generated by the proposed AWT facility will be used to fuel two 1 MW power cogenerators for the generation of electricity. Emissions from these cogenerators will be a source of NO_2. The emissions from similar operations have been assessed at Eastern Creek (**Holmes Air Sciences, 2005**) and at Jacks Gully (**Holmes Air Sciences, 2006b**). WSN currently operate the AWT at Jacks Gully (Macarthur Resource Recovery Park) which uses the same equipment and measurements have been made there allowing emission estimates to be calculated for the Lucas Heights site. A copy of the test certificate for the engines is provided in **Appendix B** and the emissions used in the modelling are summarised in **Table 5.2**.

Table 5.2: Emissions data assumed for each 1 MW unit

Parameter	Value
Stack locations (MGA coordinates)	Stack 1 – 313263, 6230548 Stack 2 – 313272, 6230553
Height	7 m
Stack tip diameter	0.36 m
Base elevation	155 m
Temperature	140 °C
Exit velocity	31.3 m/s
NO_x emission rate	0.8 g/s

In addition to the biogas generators at the AWT site, there are fifteen 1.15 MW generators which currently operate at the adjacent EDL site (**Figure 2.1**). These have been considered in the cumulative NO_2 assessment detailed in **Section 7**.

5.3 Dust

The main source of dust for this project will be that generated through construction of the facility, predominantly the earthworks involved in preparing the building surface. There are a number of activities involved in this process but the main sources are likely to be the use of equipment such as dozers, excavators and dump trucks as well as wind erosion from exposed areas. The use of a water cart on-site during the construction phase will aid in reducing these emissions significantly.

In order to get an estimate of what emissions may be expected, emissions have been calculated on information provided by WSN and are summarised in **Table 5.3**.

There will be other sources such as heavy vehicle movement on unsealed roads, but these are not as easily quantifiable due to the highly variable distances travelled. The use of a water cart will assist to substantially reduce these emissions.

Table 5.3: Estimated emissions due to earthworks at the proposed AWT site

Source	Emission factor[i]	Total emission (kg)
Three dozers working 9 h/d for 80 days each	14 kg/h	30,240
Excavator moving material	0.00152 kg/t	80[j]
Trucks dumping material	0.00152 kg/t	80
Wind erosion over approximately 3.5 ha of exposed area	0.4 kg/ha/h	255[k]
Total emissions over the 6-month earthworks construction period		**30,655 kg**

Dust emissions of this scale are unlikely to cause any adverse impacts at the nearest residential areas. There are major dust producing industries such as quarries which emit dust at rates significantly greater than this and still comply with both health and nuisance criteria. There may be short-term nuisance impacts at locations adjacent to the site and these will generally occur on days where wind speeds are elevated.

6 APPROACH TO ASSESSMENT

In August 2005, the DECC published guidelines for the assessment of air pollution sources using dispersion models (**DEC, 2005**). The guidelines specify how assessments based on the use of air dispersion models should be undertaken. They include guidelines for the preparation of meteorological data, emissions data and relevant air quality criteria. The approach taken in this assessment follows as closely as possible to the approaches suggested by the guidelines.

Off-site odour levels due to both the existing landfill operations and the proposed AWT facility have been predicted using CALPUFF. CALPUFF has also been used to predict off-site NO_2 levels due to the combustion of biogas at the AWT facility.

The CALPUFF model used makes use of three-dimensional wind fields generated by the CALMET model. Modifications that are imposed on this interpolated wind field (by topography and differential heating and differential roughnesses) are then applied to the winds at each grid point to develop a final wind field. The final wind field reflects the effect of local topography and the effects of different temperatures experienced by water bodies and land surfaces as well as different surface roughnesses that arise because of changes in vegetation or other variations in land use such as the presence of towns, agricultural land and forest land, etc.

Odour and NO_2 levels have been predicted over an area 4 km by 4 km (100 m spacing) and local terrain has been taken into account. The modelling has been performed using the meteorological data discussed in **Section 4.1** and the emission estimates from **Section 5**.

The way in which the model has been used in the odour assessment has been to predict the 1-hour average odour levels corrected to nose response times (expressed in odour units) at each receptor.

[i] *Using equations from **US EPA, 1995 and updates***

[j] *Assuming a total of 51,000 m^3 of material is handled over the construction period. This source is wind speed dependant so when winds are light the emissions will be low*

[k] *Assuming the total 3.5 ha is exposed for a total of 6 months*

The 1-hour averaging times have been used for consistency with the DECC odour criteria. For the assessment of NO_2, predictions were made for both 1-hour and annual average time periods.

Sources were located according to the layout at each site. For the purposes of presenting the results, plots of odour levels at the 99th percentile have been compiled, showing the extent to which odours are predicted to occur for 99% of the time. The maximum 1-hour and annual average NO_2 are also presented as contour plots as discussed in **Section 7**.

7 ASSESSMENT OF IMPACTS

The results of the CALPUFF dispersion modelling using the emissions data summarised in **Table 5.1** and **Table 5.2** are presented as contour plots in **Figure 7.1** to **Figure 7.5**.

Figure 7.1 shows the predicted 99th percentile odour levels for the AWT facility only. It can be seen that the 2 ou contour is predicted to extend slightly beyond the southern boundary across New Illawarra Road and just onto the western corner of the ANSTO site. There are not predicted to be any exceedances of the 2 ou goal at any sensitive receptors in the area, such as residences or schools.

The predicted 99th percentile odour levels for the landfill site alone are shown in **Figure 7.2**. It can be seen that the 2 ou contour extends beyond the landfill boundary, but does not encroach on any of the residential areas such as Menai to the northeast, Barden Ridge to the east or Engadine to the southeast.

When assessing the AWT site in conjunction with the landfill site, the cumulative impacts are predicted as shown in **Figure 7.3**. **Figure 7.3** shows that the landfill is the dominant odour source and that the effects of the AWT operations are relatively minor. It can be seen that even though the 2 ou contour extends beyond the landfill boundary, it does not impact upon the local residential areas.

There will be occasions, every 2 to 3 years, when the acetogenic tanks require cleaning. As discussed in **Section 5.1** this will involve removing a panel from the side of the tank to enable cleaning equipment, such as a bob-cat, to enter the tank and clean it. **Figure 7.4** shows the predicted maximum odour concentrations due to the AWT only with this additional source. It can be seen that even the maximum 1-hour value (100th percentile) does not exceed 2 ou at the nearest residence. When combined with emissions from the landfill as shown in **Figure 7.5**, it can be seen that there is very little difference between these predictions and those with the AWT under general operating conditions (**Figure 7.3**). This is because the landfill is the dominant odour source in the area, as discussed previously, and also that the cleaning of the tanks is a relatively minor source at the AWT given its small area. The 2 ou level is not predicted to be exceeded at the nearest residences during the cleaning process.

Although no specific modelling was carried out for the odour from trucks in the truck parking area, a similar argument can be made as that for the cleaning operations. This source will be minor in relation to other emissions from the AWT, and also those from the landfill and composting operations and as such is unlikely to have a measureable impact on the surrounding area.

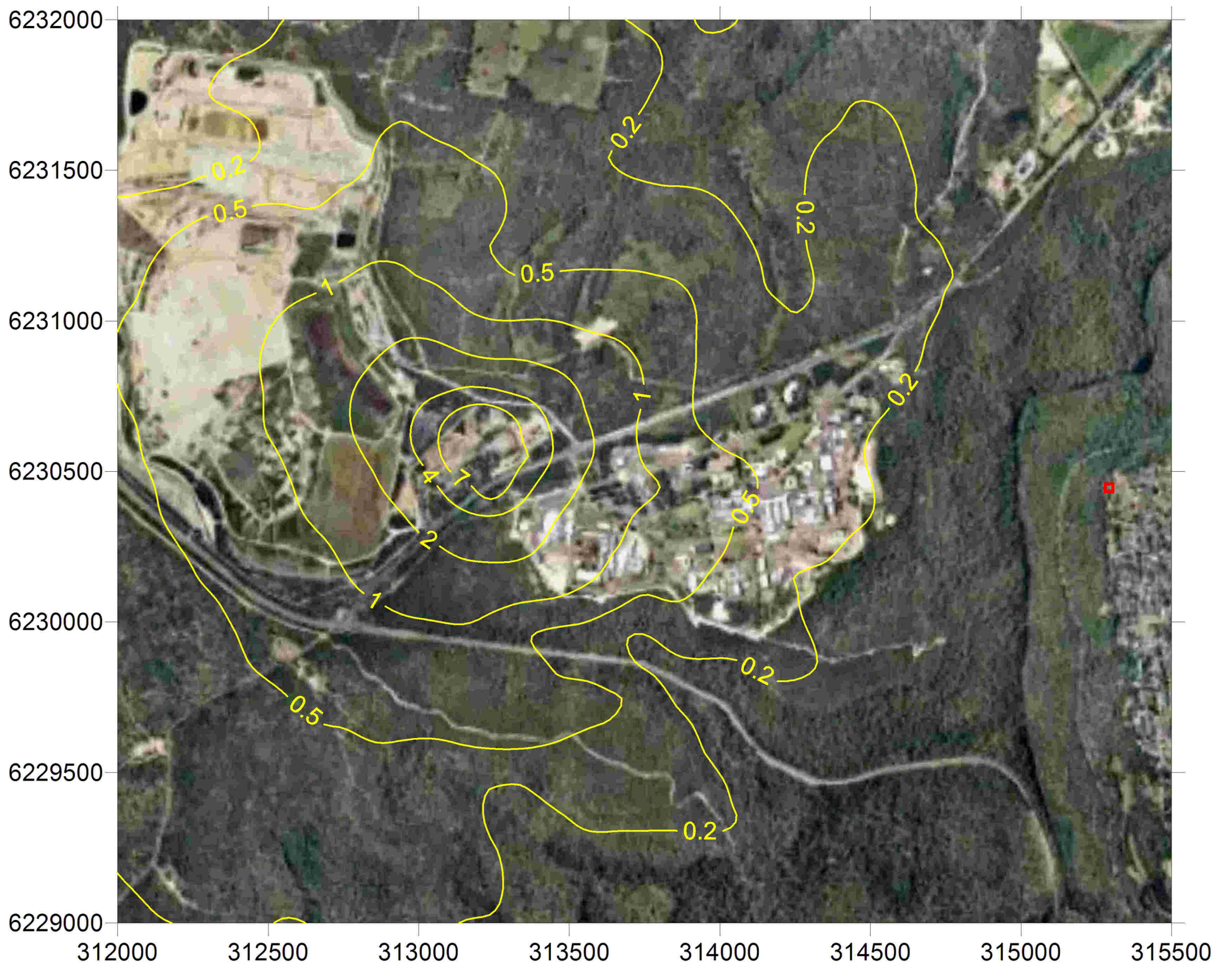
Figure 7.6 and **Figure 7.7** show the predicted 1-hour maximum and annual average NO_2 levels, respectively, due to emissions from the biogas power generation units. It has been assumed that there is full oxidation of the NO_X to NO_2 whereas in reality, it is more likely to be approximately 20%.

Even if the estimated background levels listed in **Section 4.2** are added to the modelling results, there are no predicted exceedances of the NO_2 goals at any nearby sensitive receptors, due to the AWT facility, and it is unlikely that there will be any adverse impact from these sources.

In order to determine the cumulative NO_2 impact from the AWT and the adjacent EDL site (shown in **Figure 2.1**) an assessment has been done on a pro-rata basis. There are fifteen 1.15 MW biogas generators on the EDL site. Assuming that these are all operating simultaneously this would total 17.25 MW. Combined with the two 1 MW generators at the AWT site, this would total just below 20 MW, or ten times more than the 2 MW assumed in the modelling for AWT alone.

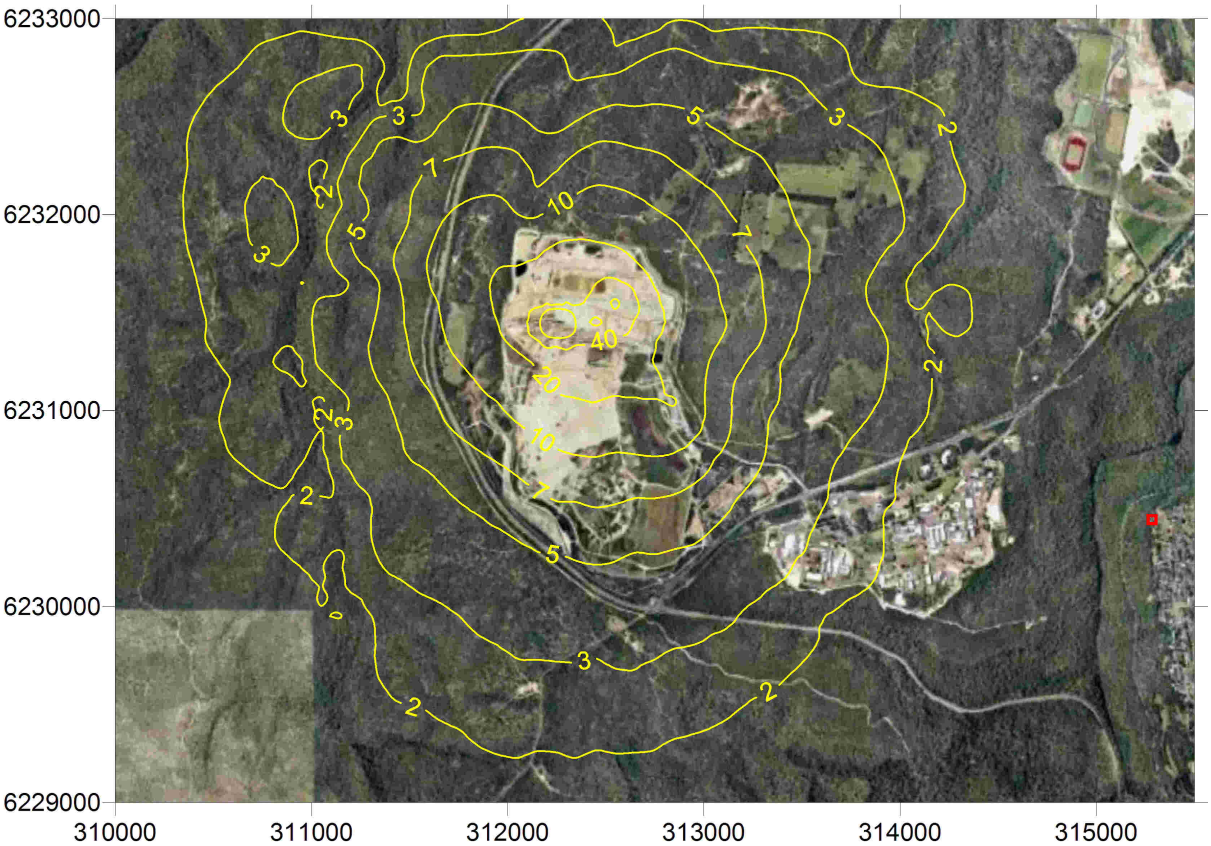
The predicted 1-hour maximum NO_x concentration at the nearest residence due to the AWT generators, is estimated to be less than 5 $\mu g/m^3$. The resulting cumulative concentration of NO_x would be of the order of 50 $\mu g/m^3$ (pro-rata – 10 x 5 $\mu g/m^3$) at the nearest residence. If it is assumed that all NO_x is converted to NO_2 and then added to the maximum 1-hour background NO_2 measurement of 166 $\mu g/m^3$,(**Table 4.2**), the resulting concentration would still be below the 246 $\mu g/m^3$ goal. This is a very conservative estimate as it has assumed complete conversion from NO_x to NO_2.

It is therefore unlikely that there will be any adverse cumulative impacts due to NO_2 emissions from the AWT and EDL generators.



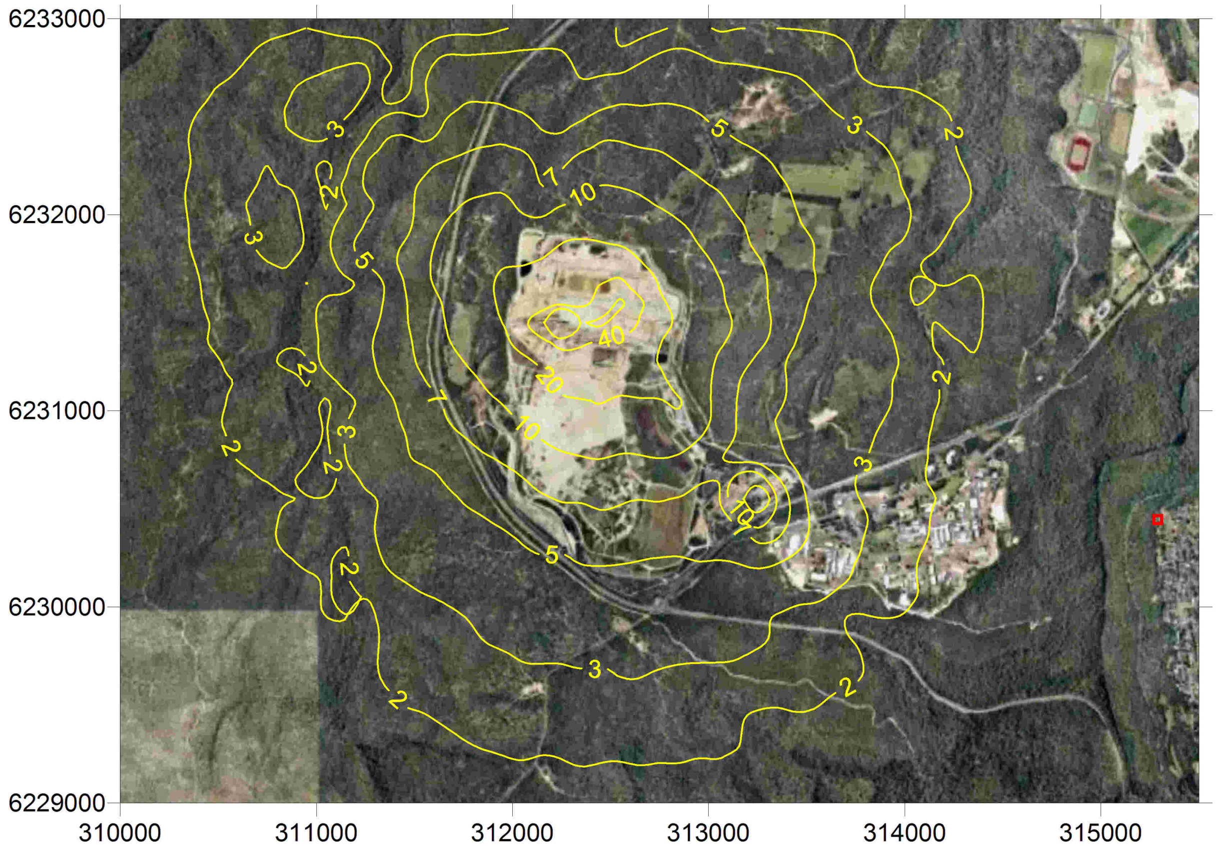
Species: Odour	Averaging Time: 1 hour	Percentile: 99th	Scenario: AWT only under general operations	Location: Lucas Heights
Model Used: CALPUFF	**Units:** Odour units	**Assessment criteria:** 2 ou	**Met Data:** Lucas Heights 2001	**Plot:** J Barnett

Figure 7.1: Predicted 99th percentile odour concentration due to emissions from the AWT only under general operating conditions



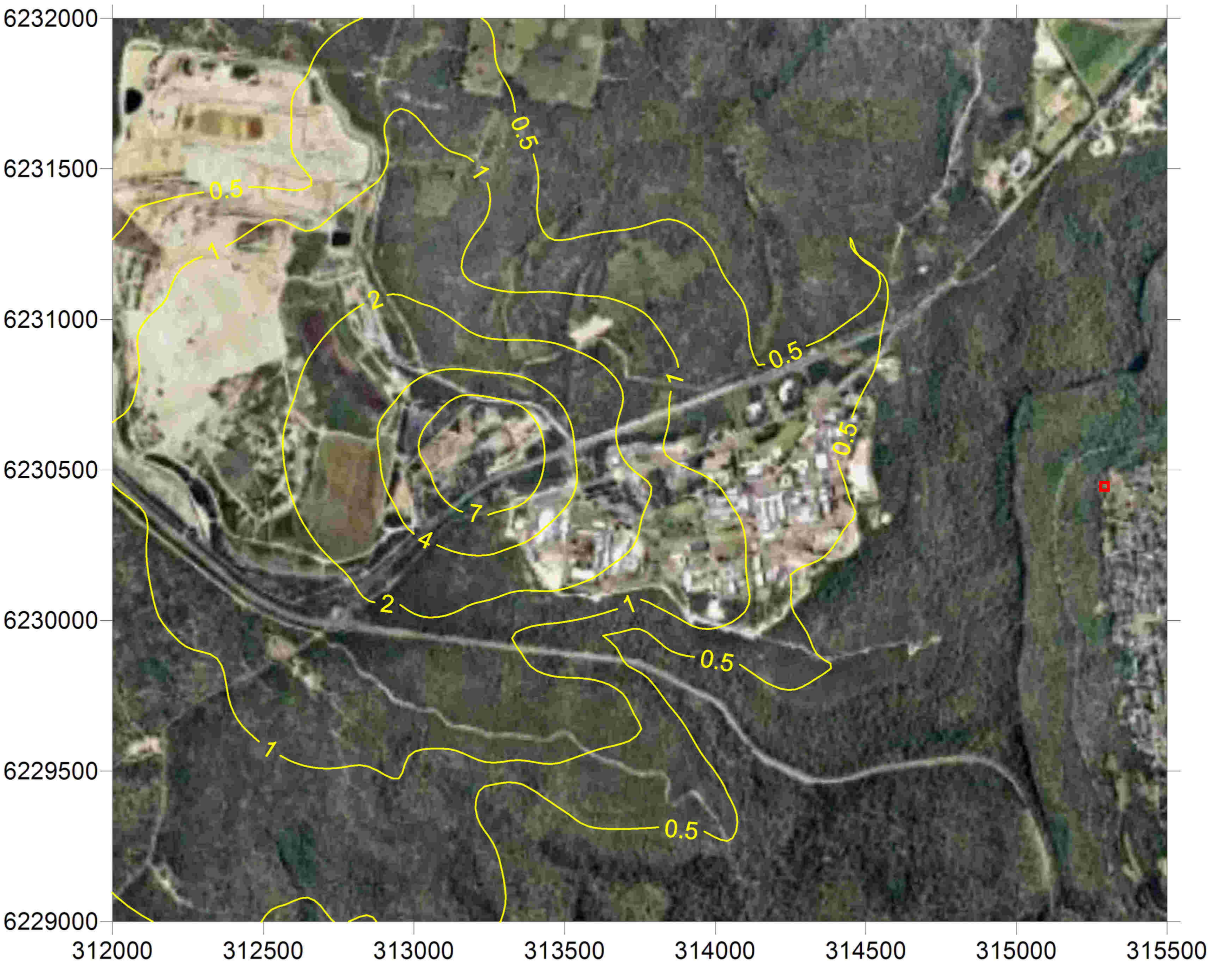
Species: Odour	**Averaging Time:** 1 hour	**Percentile:** 99th	**Scenario:** Landfill only	**Location:** Lucas Heights
Model Used: CALPUFF	**Units:** Odour units	**Assessment criteria:** 2 ou	**Met Data:** Lucas Heights 2001	**Plot:** J Barnett

Figure 7.2: Predicted 99th percentile odour concentration due to emissions from the landfill only



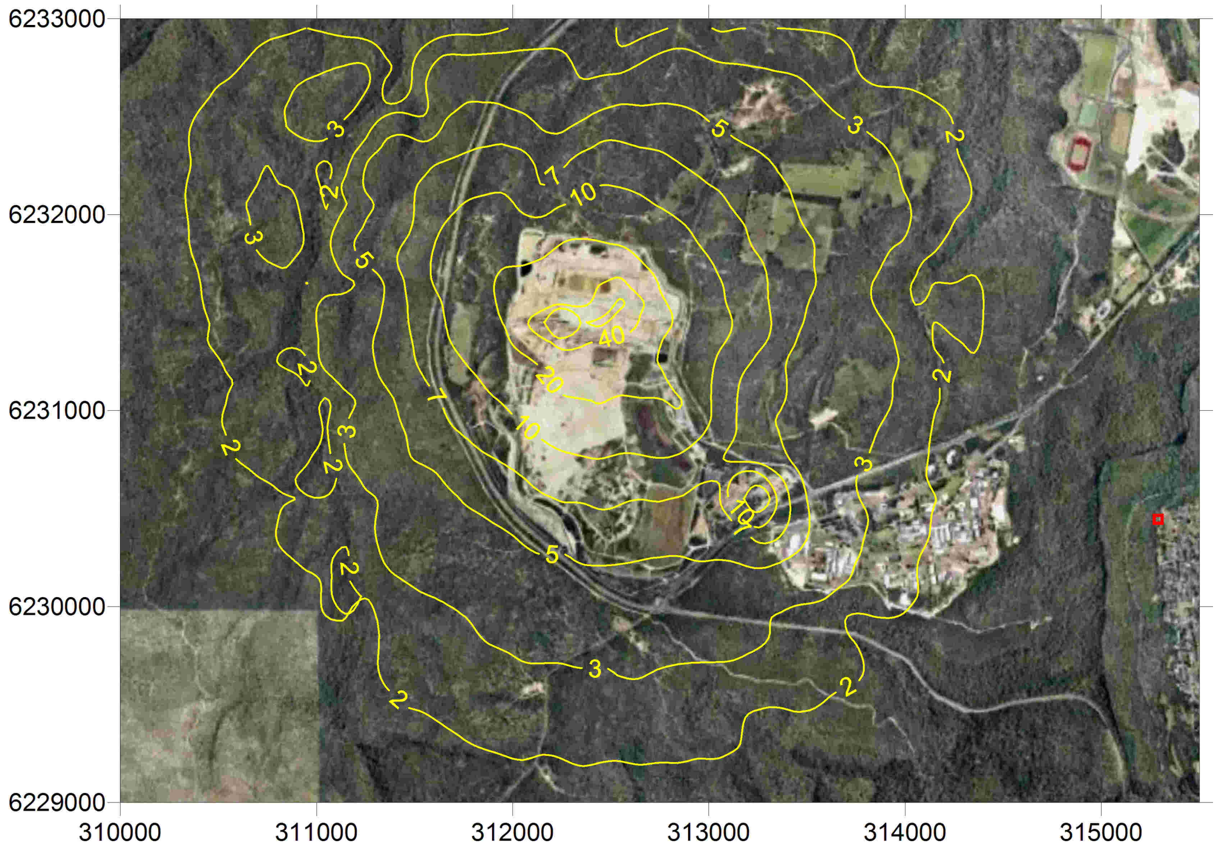
Species: Odour	Averaging Time: 1 hour	Percentile: 99th	Scenario: Cumulative (AWT under general operations)	Location: Lucas Heights
Model Used: CALPUFF	**Units:** Odour units	**Assessment criteria:** 2 ou	**Met Data:** Lucas Heights 2001	**Plot:** J Barnett

Figure 7.3: Predicted 99th percentile odour concentration due to combined emissions from the landfill and AWT under general operating conditions



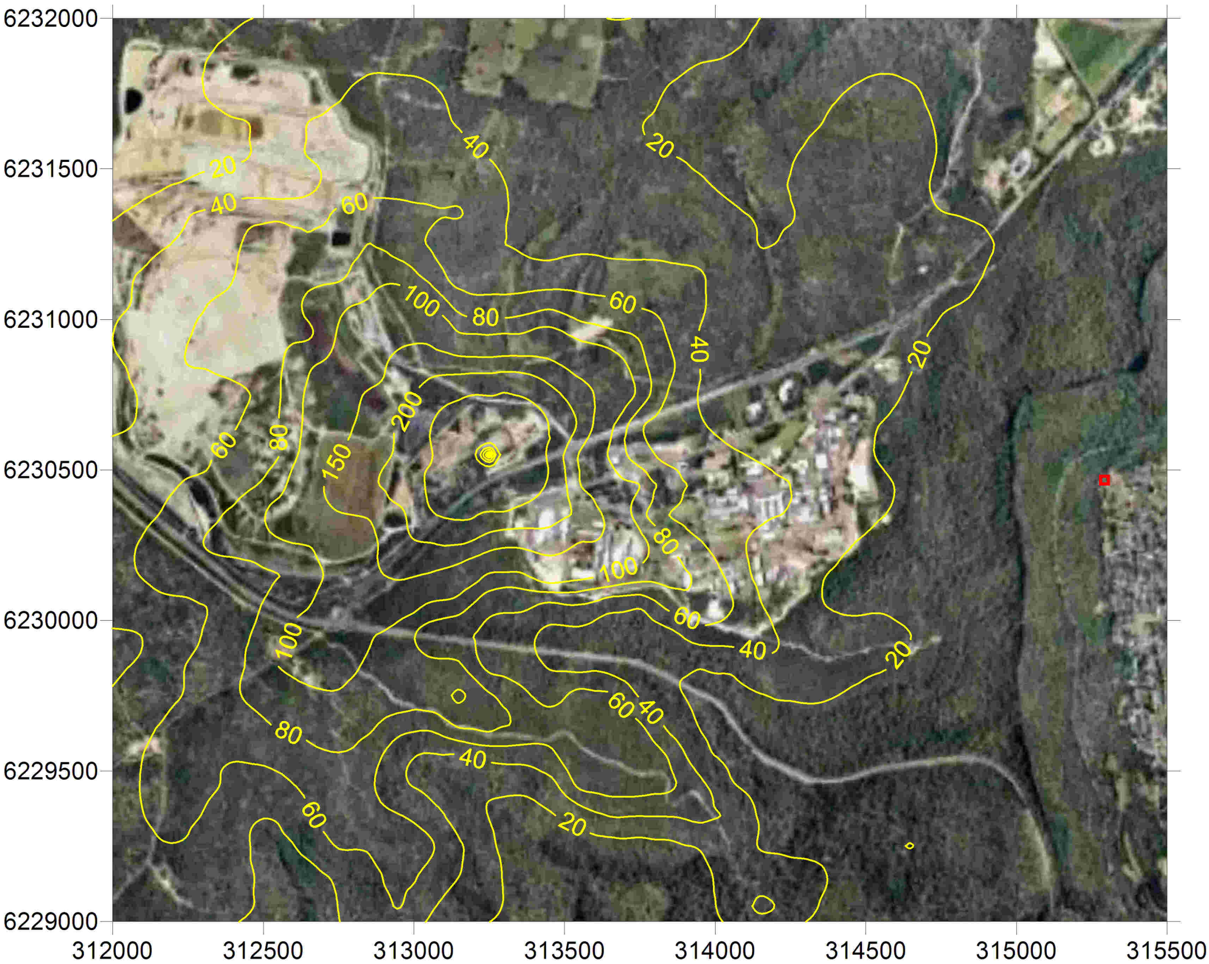
Species: Odour	Averaging Time: 1 hour	Percentile: Maximum	Scenario: AWT under cleaning operations	Location: Lucas Heights
Model Used: CALPUFF	**Units:** Odour units	**Assessment criteria:** N/A	**Met Data:** Lucas Heights 2001	**Plot:** J Barnett

Figure 7.4: Predicted maximum odour concentration due to emissions from the AWT only under cleaning operations



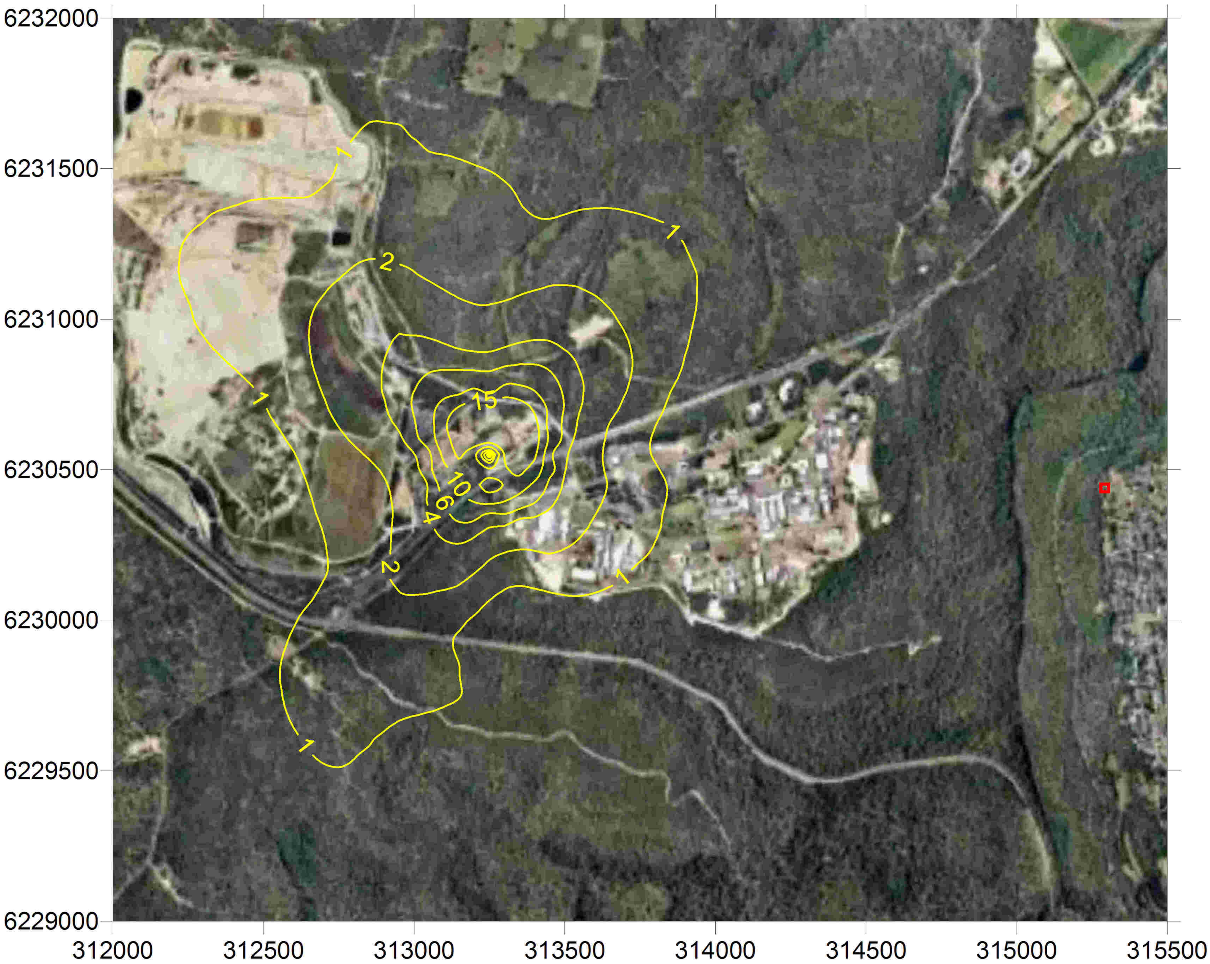
Species: Odour	Averaging Time: 1 hour	Percentile: 99th	Scenario: Cumulative (AWT under cleaning operations)	Location: Lucas Heights
Model Used: CALPUFF	**Units:** Odour units	**Assessment criteria:** 2 ou	**Met Data:** Lucas Heights 2001	**Plot:** J Barnett

Figure 7.5: Predicted 99th percentile odour concentration due to combined emissions from the landfill and AWT under cleaning conditions



Species:	Averaging Time:	Percentile:	Scenario:	Location:
NO_2	1 hour	Maximum	Two AWT generators	Lucas Heights
Model Used:	**Units:**	**Assessment criteria:**	**Met Data:**	**Plot:**
CALPUFF	µg/m^3	246 µg/m^3	Lucas Heights 2001	J Barnett

Figure 7.6: Predicted 1-hour maximum NO_2 concentrations due to emissions from the biogas generators at the AWT (assuming 100% conversion from NO_x to NO_2)



Species: NO_2	**Averaging Time:** 1 year	**Percentile:** Maximum	**Scenario:** Two AWT generators	**Location:** Lucas Heights
Model Used: CALPUFF	**Units:** µg/m³	**Assessment criteria:** 62 µg/m³	**Met Data:** Lucas Heights 2001	**Plot:** J Barnett

Figure 7.7: Predicted annual average NO_2 concentrations due to emissions from the biogas generators at the AWT (assuming 100% conversion from NO_x to NO_2)

8 MITIGATION MEASURES

The mitigation measures for this project are mainly related to dust. Measures to reduce odour are already incorporated into the design of the facility and have been included in the odour modelling. NO_x emissions are low and produce no on-site or off-site impact so there is little benefit in reducing these any further. There are however, ways in which dust emissions during construction can be kept to a minimum and these include:

- watering of unsealed haul roads and disturbed surfaces (including construction areas);
- restricting the size of disturbed areas as much as practicable;
- prevention of truck over-loading and covering dusty loads;
- washing down trucks before they leave the site; and
- temporarily suspending operations under extreme wind speed conditions.

9 CONCLUSIONS

This report provides a quantitative assessment of air quality impacts that might arise from the operation of the proposed AWT facility at the Lucas Heights Waste and Recycling Centre. Cumulative impacts of the adjacent landfill have also been assessed. Dispersion modelling was used to predict off-site odour and nitrogen dioxide levels due to the operation of the facilities.

The dispersion modelling indicates that off-site odour and nitrogen dioxide levels can be maintained at acceptable levels for the existing developments in the area. It was also determined that with dust management practices in place, dust during the construction and operation of the facility would not cause impacts at levels detrimental to the health of either the general public or workers.

10 REFERENCES

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"Air Quality Modelling Report : Jacks Gully Alternative Waste Technology Facility", prepared for GHD, March 2006.

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"Report from Katestone Scientific to Environment Protection Authority of NSW, Peak to Mean Ratios for Odour Assessments".

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"Compilation of Air Pollutant Emission Factors". AP-42, Fourth Edition United States Environmental Protection Agency, Office of Air and Radiation Office of Air Quality Planning and Standards, Research Triangle Park, North Carolina 27711. Note this reference is now a web-based document.

Appendix A: Peak to mean table

Table A1 – Recommended factors for estimating peak concentrations for different source types, distances and stabilities

Source type	Stability	Near field				Far field			p
		i_{max}	x_{max}	P/M 60	P/M 3	i	P/M 60	P/M 3	
Area	Neutral, Convective Stable	0.5 0.5	500 – 1000 300 – 800	2.5 2.3	1.9 1.7	0.4 0.3	2.3 1.9	1.7 1.4	0.15 0.10
Line	Neutral, Convective Stable	1.0 1.0	350 250	6 6	2.8 2.8	0.75 0.65	6 6	2.8 2.8	0.25 0.25
Surface point	Neutral Stable Convective	2.5 2.5 2	200 200 1000	25 25 12	10 10 7	1.2 1.2 0.6	5 - 7 5 - 7 3 - 4	3 3 2.5	0.2 0.2 0.15
Tall point	Neutral, Stable Convective	4.5 2.3	5 h 2.5 h	35 17	8 4	1.0 0.5	6 3	1.3 1.1	0.5 0.5
Wake affected point	Neutral, Convective	0.4	-	2.3	1.4	-	2.3	1.4	0.1
Volume	Neutral, Convective	0.4	-	2.3	1.4	-	2.3	1.4	0.1

i_{max} is maximum centreline intensity of concentration
x_{max} is the approximation location of i_{max} in metres
P/M 60 is the peak-to-mean ratio for long averaging times (typically 1 hour), at a probability of 10^{-3}
P/M 3 is the best estimate of the peak-to-mean ratio for 3 minute averages, at probability 10^{-3}
p is the averaging time power law exponent
h is stack height

Source: **Katestone Scientific (1998)**

Appendix B: Gas Engine Test Certificate

TEST CERTIFICATE

PAGE 1-6

QSEDOK1|QSEDOK 2 TEST BED C2

ENGINE TEST CERTIFICATE ACCORDING TO	ISO 3046	GENSET TEST CERTIFICATE ACCORDING TO	ISO 8528

PASSWORD: Jacks Gully 2
Order-No.: 286670
Outfit-No.: J E338
Customer: Clarke Energy (Australia) Pty Ltd

GENERATOR SET

Manufacturer:	GEJenbacher	Type:	JMC 420 GS-B.L	Number:	5314081

ENGINE

Manufacturer:	GEJenbacher	Type:	J 420 GS-A125	Number:	5314091
Coolant:	50% Glycol - Water	Starter:	E-Starter	Oil:	Mobil Pegasus 705

ALTERNATOR

Manufacturer:	NEWAGE STAMFORD	Type:	PE 734 F2	Number:	0232130/001
Style:	IM 1001		Safety Class: IP 23	Isolation class:	H
Nominal Power:	2080 kVA	cosφ	0,8	Nominal Voltage:	415 V
Nominal Current:	2894 A			Nominal Frequency:	50 Hz

SWITCHGEAR

Type:	Number:	Manufacturer:	Type:	Number:	Manufacturer:
Module Control	2495726	Greilhuber	Power Panel	IK 40680	EAE Stöckl
Interface	2495725	GE Jenbacher			

NOMINAL VALUES OF GEN-SET

ELECTRIC POWER		1415	kW
ENGINE OUTPUT		1451	kW
NOMINAL VOLTAGE		415	V
NOMINAL CURRENT		1969	A
NOMINAL POWER FACTOR		1,00	cosφ
SPEC. HEAT CONSUMPTION	(+|- 5%)	2,33	kWh|kWh
ELECTRICAL EFFICIENCY		41,9	%
HIGH TEMP. CIRCUIT THERMAL OUTPUT	(+|- 8%)	1411	kW 3)
LOW TEMP. CIRCUIT THERMAL OUTPUT	(+|- 8%)	62	kW 3)
MIXTURE TEMPERATURE		60	°C
ENGINE COOLANT DISCHARGE TEMP.		90	°C
SPEED		1500	min^{-1}|RPM
NOx		400	mg|mn^3
CO		-	mg|mn^3
-		-	

FUEL GAS (at test bench) NATURAL GAS

LOWER CALORIC VALUE	10,06	kWh|m_n^3	MZ	91,7
DENSITY	0,738	kg|m_n^3		

IGNITION TIMING 20 °crankshaft before TDC

test run,date	tested by
15.11.2007	Gamper Helmut

released Assembly Quality

Haaser Martin

TEST CERTIFICATE

PAGE 2-6
QSEDOK1|QSEDOK 2 TEST BED C2

PASSWORD: *Jacks Gully 2*
ENGINE-TYPE: *J 420 GS-A125*
ENGINE-NR.: *5314091*

			1	2	3	4	5	6	7	8
	MEASURING-NO.		1	2	3	4	5	6	7	8
	ENGINE LOAD	[%]	101	101	51	51	76	76		
	TIME	[hh:mm]	11:36	11:39	12:00	12:03	12:12	12:15		
	TEST RUN CONDITIONS		**1)**							
1	BAROMETRIC PRESSURE	mbar	949,5	949,7	949,8	949,9	949,9	949,8		
2	INTAKE AIR TEMPERATURE	°C	10	10	6	6	8	8		
3	RELATIV AIR HUMIDITY	%	#	#	#	#	#	#		
	CAPACITY									
4	ENGINE SPEED	min^{-1} RPM	1500	1500	1500	1500	1500	1500		
5	FREQUENCY	Hz	50	50	50	50	50	50		
6	VOLTAGE	V	405	405	406	406	407	406		
7	CURRENT	A	2037	2037	1010	1011	1518	1520		
8	POWER FACTOR	cosφ	1,00	1,00	1,00	1,00	1,00	1,00		
9	ELECTRICAL OUTPUT	kW	1429	1429	710	711	1070	1069		
10	GENERATOR EFFICIENCY	%	97,5	97,5	96,9	96,9	97,4	97,4		
11	ENGINE OUTPUT	kW	1466	1466	733	734	1099	1098		
12	Reserve		#	#	#	#	#	#		
13	Reserve		#	#	#	#	#	#		
	FUEL CONSUMPTION at				**cos φ = 1,0**					
14	GASFLOW RATE	m^3|h	354,0	353,8	175,1	174,8	259,3	259,0		
15	GAS PRESSURE	mbar	104	104	189	189	153	153		
15	GAS TEMPERATURE	°C	14,1	14,1	14,8	14,8	13,9	13,7		
17	NORMAL GASFLOW RATE (0°C, 1013,25 mbar)	m_n^3|h	350,0	349,9	186,7	186,4	268,6	268,4		
18	FUEL CALORIFIC INPUT	kW	3519	3519	1878	1875	2702	2701		
19	SPECIFIC HEAT CONSUMPTION	kWh|kWh	2,401	2,401	2,562	2,555	2,459	2,460		
20	ELECTRICAL EFFICIENCY	%	40,6	40,6	37,8	37,9	39,6	39,6		

TEST CERTIFICATE

PAGE 3-6
QSEDOK1|QSEDOK 2 TEST BED C2

PASSWORD: Jacks Gully 2
ENGINE-TYPE: J 420 GS-A125
ENGINE-NR.: 5314091

	MEASURING-NO.		1	2	3	4	5	6	7	8
	ENGINE LOAD	[%]	101	101	51	51	76	76		
	TIME	[hh:mm]	11:36	11:39	12:00	12:03	12:12	12:15		
	CALCULATION at cosφ = 1									
21	GENERATOR EFFICIENCY	%	97,5	97,5	96,9	96,9	97,4	97,4		
22	ELECTRICAL OUTPUT	kW	1429	1429	710	711	1070	1069		
23	ELECTRICAL EFFICIENCY	%	40,6	40,6	37,8	37,9	39,6	39,6		
	HIGH TEMPERATURE COOLING CIRCUIT									
24	HIGH TEMP. CIRCUIT WATER TEMPERATURE INLET	°C	#	#	#	#	#	#		
25	HIGH TEMP. CIRCUIT WATER TEMPERATURE OUTLET	°C	#	#	#	#	#	#		
26	HIGH TEMP. CIRCUIT WATER FLOW RATE	m^3/h	#	#	#	#	#	#		
27	HIGH TEMP. CIRCUIT THERMAL OUTPUT	kW	#	#	#	#	#	#		
	LOW TEMPERATURE COOLING CIRCUIT									
28	LOW TEMPERATURE COOLANT TEMP. INLET	°C	#	#	#	#	#	#		
29	LOW TEMPERATURE COOLANT TEMP. OUTLET	°C	#	#	#	#	#	#		
30	LOW TEMP. CIRCUIT FLOW RATE	m^3/h	#	#	#	#	#	#		
31	LOW TEMP. CIRCUIT THERMAL OUTPUT	kW	#	#	#	#	#	#		
	ENGINE COOLANT									
32	COOLINGWATER TEMP. INLET	°C	81,9	81,8	80,5	80,5	81,9	81,8		
33	COOLINGWATER TEMP.OUTLET	°C	87,3	87,2	83,9	84,0	86,1	86,2		
34	RESERVE		#	#	#	#	#	#		
	ENGINE OIL									
35	OILTEMP. BEFORE COOLER	°C	#	#	#	#	#	#		
36	OILTEMP. AFTER COOLER	°C	72,6	73,4	71,2	71,2	72,5	72,1		
37	OILPRESSURE BEFORE FILTER	bar	4,1	4,1	4,2	4,2	4,2	4,2		
38	OILPRESSURE AFTER FILTER	bar	4,0	4,0	4,1	4,1	4,0	4,0		

TEST CERTIFICATE

PAGE 4-6
QSEDOK1|QSEDOK 2 TEST BED C2

PASSWORD: Jacks Gully 2
ENGINE-TYPE: J 420 GS-A125
ENGINE-NR.: 5314091

			1	2	3	4	5	6	7	8
	MEASURING-NO.		1	2	3	4	5	6	7	8
	ENGINE LOAD	[%]	101	101	51	51	76	76		
	TIME	[hh:mm]	11:36	11:39	12:00	12:03	12:12	12:15		
AIR-MIXTURE										
39	MIXTURE TEMP. AFTER INTERCOOLER	°C	43	42	37	37	41	41		
40	PRECHAMBER GAS PRESSURE	mbar	#	#	#	#	#	#		
41	BOOST PRESSURE BEFORE THROTTLE-FLAP	mbar	2206	2211	727	720	1426	1434		
42	BOOST PRESSURE AFTER THROTTLE-FLAP	mbar	2191	2195	663	664	1416	1413		
43	PRESSURE DROP INTERCOOLER	mbar	#	#	#	#	#	#		
POWER RESERVE										
44	TURBOBYPASS POSITION	%	53	53	44	44	65	65		
45	TECJET POSITION		1,83	1,83	1,78	1,78	1,78	1,78		
46	THROTTLE VALVE POSITION	%	100	100	70	70	99	99		
47	IGNITION TIMING	°cs. b. TDC	20	20	20	20	20	20		
EXHAUST GAS										
48	EXHAUST GAS PRESSURE	mbar	#	#	#	#	#	#		
49	EXHAUSTGAS TEMP. AFTER ENGINE	°C	398	398	450	451	421	421		
50	O2-CONTENT EXHAUST GAS	%	10,82	10,82	10,53	10,54	10,69	10,69		
51	CO-CONTENT EXHAUST GAS (without Oxicat)	mg|mn3	894	894	804	804	869	873		
52	NOx-CONTENT EXHAUST GAS	mg|mn3	377	369	393	377	308	304		

TEST CERTIFICATE

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QSEDOK1|QSEDOK 2 TEST BED C2

PASSWORD:	*Jacks Gully 2*
ENGINE-TYPE:	*J 420 GS-A125*
ENGINE-NR.:	*5314091*

REMARKS

\# ... in the field of measured quantity ... not available or not measured
Exhaustgas emissions with reference to 5 % O2 in dry exhaust gas

1) Further test run conditions: Sea level: 520m; Ambient temperature = air intake temperature

3) Thermal Output measured with: 50% Glycol - Water

TEST CERTIFICATE

PAGE 6-6
QSEDOK1|QSEDOK 2 TEST BED C2

PASSWORD:	*Jacks Gully 2*
ENGINE-TYPE:	*J 420 GS-A125*
ENGINE-NR.:	*5314091*

Prozess - Gaschromatograph PGC 9000 VC

Natural Gas
Analysis Report

Sample Name:	Erdgas
Injection Date:	07.11.2007 16:50
Operator:	Tosser

Component	Vol %
Oxygene (O_2)	0,0000%
Nitrogene (N_2)	0,8469%
Methane (CH_4)	97,3686%
n-Hexane (C_6H_{14})	0,0066%
Carbon Dioxide (CO_2)	0,1709%
Ethane (C_2H_6)	1,1220%
Propane (C_3H_8)	0,3519%
i-Butane (i-C_4H_{10})	0,0551%
n-Butane (n-C_4H_{10})	0,0572%
i-Pentane (i-C_5H_{12})	0,0116%
n-Pentane (n-C_5H_{12})	0,0093%
neo-Pentane (neo-C_5H_{12})	0,0000%
Summe:	100,0000%

Lower Caloric Value at 0°C [kWh/m_n^3]	**10,060**
Methan number:	**91,66**
Density/ 0°C	**0,738**

Reference: ISO 6976: 1995(E)

END OF THE REPORT