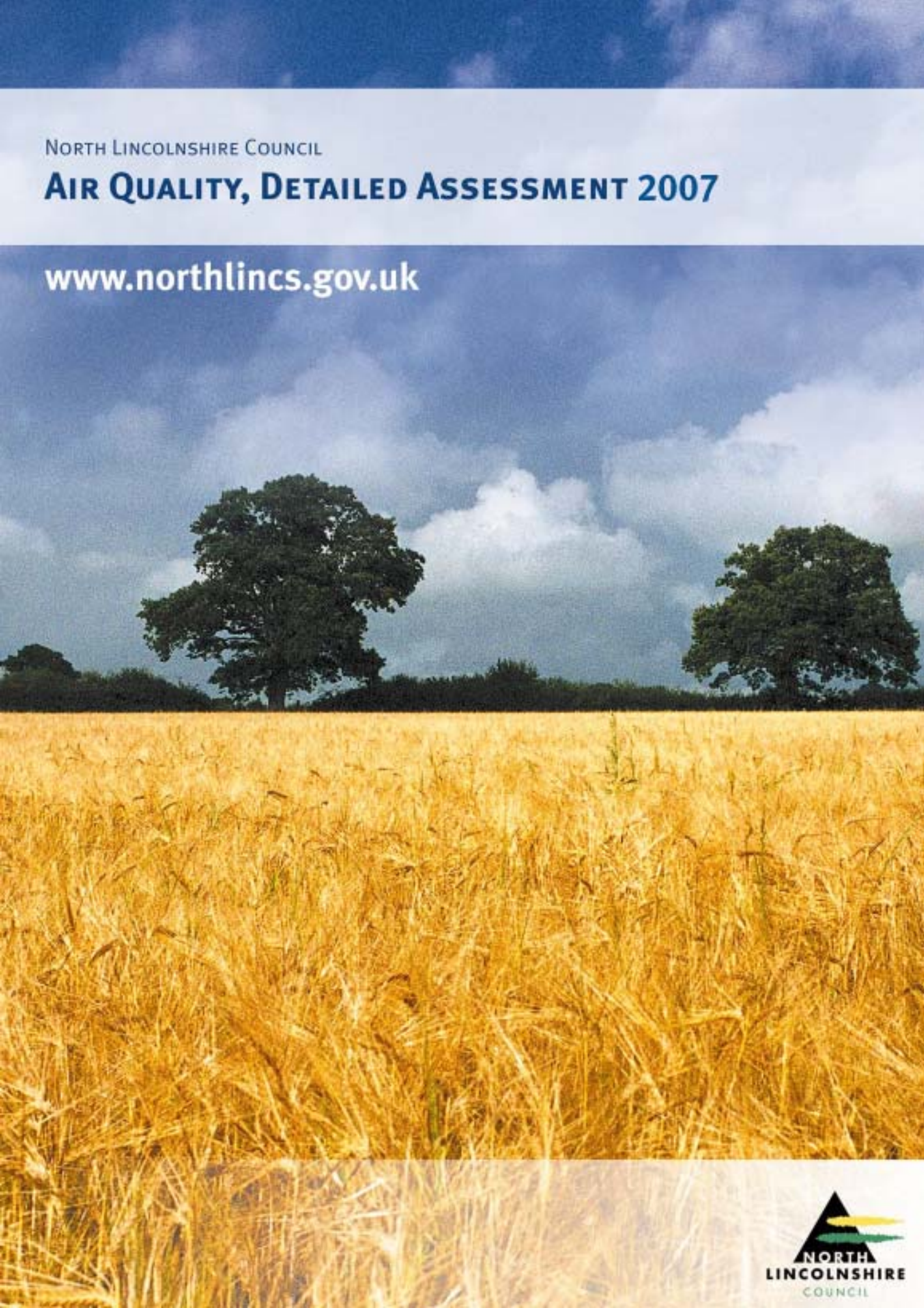


NORTH LINCOLNSHIRE COUNCIL

AIR QUALITY, DETAILED ASSESSMENT 2007

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Executive Summary

This Detailed Assessment was submitted to Defra in three separate sections due to the need to monitor for lead, the section on 1,3 Butadiene was submitted on the 18th April 2007, the Nitrogen Dioxide section on 9th May 2007 and the lead report was submitted on 23rd July 2007. The separate reports have now been merged into a single document.

1,3 Butadiene

The two refineries in Killingholme reported a significant increase in their 1,3 Butadiene emissions in 2004 and 2005 compared to previous years as a result of a change in the reporting methodology. Consequently the Updating and Screening Assessment report (2006) concluded that North Lincolnshire Council should proceed to a detailed assessment for 1,3 Butadiene. However, it was decided that a further scaling exercise would be carried out to determine whether any detailed modelling or monitoring are necessary, to achieve this results from a Benzene diffusion tube survey that North Lincolnshire Council carried out in 2004 and the Benzene emissions from the two refineries were used in a scaling exercise.

With this data three scenarios were considered, 1. A worst-case scenario based on the highest monthly Benzene concentration measured at an installation boundary, 2. A worst-case scenario based on the highest monthly Benzene concentration measured at a sensitive receptor. The first and second scenarios also assumed all the Benzene originated from the refineries. 3. A realistic receptor scenario using the highest annual mean concentration at a sensitive receptor but taking account of the background concentration.

The calculations showed that even in the worst-case scenario the concentration of 1,3 Butadiene would be equivalent to 51.7% of the Air Quality Objective. Scenario 3, a more realistic scenario, resulted in a concentration that was equivalent to 19.9% of the Air Quality Objective. The calculations show that road traffic is likely to be a more significant contributor to 1,3 Butadiene concentrations for those receptors that are close to Humber Road. Thus it is extremely unlikely that the Air Quality Objective is being breached in the Killingholme area and so no further work will be necessary at this time.

Lead

As a result of the 2006 Updating and Screening Assessment North Lincolnshire Council proceeded to a detailed assessment for lead (Pb) in the Scunthorpe area.

Approximately six months of Partisol filters from the Scunthorpe Town monitoring site and three months of Partisol filters from the High Santon monitoring site were analysed for lead. The mean concentration recorded at Scunthorpe Town was $0.022 \mu\text{g m}^{-3}$ and at High Santon it was $0.076 \mu\text{g m}^{-3}$. These values are below the current (2004) objective of $0.5 \mu\text{g m}^{-3}$ and the 2008 objective of $0.25 \mu\text{g m}^{-3}$.

Although a full year's worth of monitoring was not undertaken, North Lincolnshire Council is satisfied that the objectives are being met and that no further monitoring of lead in the Scunthorpe area need take place. An Air Quality Management Area does not need to be declared. However, emissions from industrial processes in Scunthorpe will continue to be examined as part of the Review and Assessment process.

A small amount of source apportionment work has been carried out. In line with expectations, the wind frequency roses drawn suggest that the highest lead concentrations occur when the wind more frequently originates from the southeast for Scunthorpe Town and the southwest for High Santon. In addition, the weekly PM₁₀ and lead concentrations at Scunthorpe Town seemed to fluctuate in a very similar manner. This relationship was less distinct at High Santon. The expected source of lead emissions is the Sinter Plant and the wind roses shown support this.

Nitrogen Dioxide

As a result of the 2006 Updating and Screening Assessment North Lincolnshire Council was required to proceed to a detailed assessment for Nitrogen Dioxide (NO₂) in certain locations, i.e. those that were highlighted as showing the potential to breach an NO₂ objective in North Lincolnshire.

The results from North Lincolnshire Council's automatic monitoring stations are reported and indicate that neither the annual or hourly NO₂ Air Quality Objectives were breached in 2006 at any of the sites. Diffusion tube results were corrected for their bias using results from a triplicate study at the Scunthorpe Town monitoring site. Once this was done the results show that in the vicinity of the junction of Brigg Road and the A18, the annual mean Objective was breached in 2006. Subject to funding from Defra an automatic monitor will be installed at this location. The annual mean Objective was not breached in any other location.

Nitrogen Dioxide concentrations at Humber Road were considered with several DMRB runs, as the current tube may not be in a worst-case scenario location. The Nitrogen Dioxide tubes route will be changed to reflect this and the locations of other diffusion tubes were re-considered.

Industrial Emissions Screening Tool calculations were re-done for Singleton Birch, Caparo Merchant Bar, Fibrogen and Edinburgh Oil and Gas, as the original background concentrations used seemed unusually high. These re-calculations showed that no further work is necessary in the respect of emissions from these companies.

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Abbreviations

Numbers in superscript indicate references, which are detailed in the Appendix.

AURN	Automatic and Urban Rural Network.
DMRB	Design Manual for Road and Bridges (macro tool)
EPAQS	Expert Panel on Air Quality Standards.
IEST	Industrial Emissions Screening Tool
LAT	Lower Assessment Threshold
NAEI	National Atmospheric Emissions Inventory
NAQS	National Air Quality Strategy
ng m ⁻³	Nanograms per cubic metre. 1 µg m ⁻³ is equal to 1000 ng m ⁻³ .
NO	Nitric oxide
NO ₂	Nitrogen dioxide
NO _x	Oxides of nitrogen
O ₃	Ozone
PAH	Poly-aromatic Hydrocarbon
Pb	Chemical symbol for lead.
PM ₁₀	Particulate matter less than 10 µm in diameter.
SO ₂	Sulphur dioxide
µg m ⁻³	Micrograms (1 millionth of a gram) per cubic metre.

- Any Tables or Figures with an 'A' preceding the number are located in the Appendix.

- Where a month has been referred to in terms of exposure of NO₂ tubes, this in fact refers to particular dates of exposure as detailed in Table A11.

Chapter 1: Introduction

The layer of the atmosphere from the Earth's surface to a height of about 15 km is known as the troposphere. In the UK, tropospheric pollutants that are thought to cause the most serious risk to human health are assigned an Air Quality Standard.

Part 1.1: Local Air Quality Management

The concept of Local Air Quality Management was introduced under Part IV of the Environment Act 1995. Chapter 82 of the Act placed a duty on all Local Authorities to review air quality in their area.

Air Quality Objectives can be defined as the Government's medium term objectives. They are based on Air Quality Standards set by the Expert Panel on Air Quality Standards and are the maximum acceptable level of a pollutant in the air that will not present a risk to the health of the most susceptible groups in the population. The Air Quality Objectives include a date by which the Standards must be achieved. The length of time to achieve the Standard for each pollutant takes into account the costs to industry, the expected rate of improvements in available technology and the health effects on the country's population.

The Air Quality (England) Regulations 2000 set Air Quality Objectives for seven pollutants that must be achieved by varying dates, the latest being 31st January 2010. The Air Quality Objectives for the seven pollutants are listed in Table 1.1. Where an Objective is unlikely to be achieved within North Lincolnshire the area must be designated an Air Quality Management Area (AQMA). The Authority must then make a further assessment into the sources of the pollutant and then develop and implement a local action plan setting out measures to reduce concentrations of the pollutant.

Pollutant	Objective		To Be Achieved By
	Concentration	Measured as	
Benzene	16.25 $\mu\text{g}/\text{m}^3$	Running Annual Mean	31/12/2003
	5 $\mu\text{g}/\text{m}^3$	Annual Mean	31/12/2010
1,3-Butadiene	2.25 $\mu\text{g}/\text{m}^3$	Running Annual Mean	31/12/2003
Carbon Monoxide	10.0 mg/m^3	Maximum Daily Running 8-Hour Mean	31/12/2003
Lead	0.5 $\mu\text{g}/\text{m}^3$	Annual Mean	31/12/2004
	0.25 $\mu\text{g}/\text{m}^3$	Annual Mean	31/12/2008
Nitrogen Dioxide	200 $\mu\text{g}/\text{m}^3$	1-Hour Mean not to be exceeded more than 18 times a year.	31/12/2005
	40 $\mu\text{g}/\text{m}^3$	Annual Mean	31/12/2005
Particles (PM ₁₀)	50 $\mu\text{g}/\text{m}^3$	24-Hour Mean not to be exceeded more than 35 times a year.	31/12/2004
	40 $\mu\text{g}/\text{m}^3$	Annual Mean	31/12/2004
Sulphur Dioxide	350 $\mu\text{g}/\text{m}^3$	1-Hour Mean not to be exceeded more than 24 times a year.	31/12/2004
	125 $\mu\text{g}/\text{m}^3$	24-Hour Mean not to be exceeded more than 3 times a year.	31/12/2004
	266 $\mu\text{g}/\text{m}^3$	15-Minute Mean not to be exceeded more than 35 times a year.	31/12/2005

Table 1.1: Air Quality Objectives in the Air Quality (England) Regulations 2000.

Part 1.2: North Lincolnshire

North Lincolnshire is an area of around 85,000 hectares located on the southern side of the Humber estuary and occupying tracts of land on either side of the River Trent. A Parliamentary Order created the administrative area of North Lincolnshire in March 1995 and on 1st April 1996 the new Unitary Authority area of North Lincolnshire came into being.

North Lincolnshire covers a large, mainly agricultural area. The pattern of settlements in the area reflects this with market towns surrounded by many small villages. The exception to this is the substantial urban area of Scunthorpe and the adjoining town of Bottesford.

Almost half of North Lincolnshire's population, approximately 60,000 people, live in Scunthorpe and the adjacent town of Bottesford. Overall, 71 percent of the population live in this main urban area and other towns.

The local economy of North Lincolnshire was built on traditional industries such as steel manufacturing and related industries and agriculture. More recently there has been the establishment of two oil refineries and the introduction of several gas fired power stations.

The M180 and M181 motorways and several primary and strategic routes, including the A18 and A15, are located within North Lincolnshire. By rail there are regular freight movements to and from the Scunthorpe Steelworks and Humber port related industries. With several wharf facilities along the banks of the Humber and the Trent, North Lincolnshire is well positioned to take advantage of water transport.

Air Quality monitoring currently conducted by North Lincolnshire Council consists of:

- 8 TEOMs for the detection of Particulate Matter less than 10 micrometres in diameter (PM₁₀).
- 2 Partisol 2025s for the gravimetric detection of PM₁₀.
- 34 diffusion tubes to record Nitrogen Dioxide (NO₂).
- 5 sites (including 2 Airpointers) to record oxides of Nitrogen (NO_x).
- 3 sites capable of recording Sulphur Dioxide.
- 2 co-located Poly Aromatic Hydrocarbon monitors (run on behalf of Defra.)
- A Benzene diffusion tube survey was conducted between November 2003 and November 2004.

Chapter 2: 1,3 Butadiene Detailed Assessment

Part 2.1: Introduction

As shown in Table 1.1 the Air Quality Standard for 1,3 Butadiene is $2.25 \mu\text{g m}^{-3}$, this is based on a running annual mean, with the Objective date for compliance being 31st December 2003.

As part of the Updating and Screening Assessment 2006 no new industrial sources of 1,3 Butadiene were identified within North Lincolnshire. However, two existing sources, Total UK Lindsey Oil Refinery and Conoco Phillips Humber Refinery in Killingholme (which can be seen in Figures A1 and A4 in the Appendix) were identified as reporting significantly increased emissions since the previous Updating and Screening Assessment in 2003. Both are Part A(1) industrial processes and are regulated by the Environment Agency. The 1,3 Butadiene annual mass emissions for the two refineries from 2002 to 2005 are detailed in Table 2.1.

Type of Process	Operator	Permit Reference	Receptor Distance	1,3 Butadiene Mass Emission (T), by year			
				2002	2003	2004	2005
Gasification and Refining	Total UK Ltd Oil Refinery	AF6928	840m	< 1	< 1	12	11
Gasification and Refining	Conoco Phillips Ltd, Humber Refinery	AF8173	840m	< 1	< 1	12	12

Table 2.1: Industrial emissions of 1,3 Butadiene within North Lincolnshire from 2002 to 2005.

Although the mass emission of 1,3 Butadiene for 2005 has substantially increased it should be noted that the methodology for calculating the mass emission has changed. The new method involves twice yearly fence-line speciation studies carried out by the refineries to determine the ratio of speciated for a range of volatile organic compounds. The mass emission is then calculated using a standard methodology agreed with the Environment Agency.

As each installation exceeded the per annum emission level determined by the LAQM Technical Guidance tool (3.66 tonnes) there is a likelihood that the Air Quality Objective for 1,3 Butadiene may be breached. As a result North Lincolnshire Council concluded that it should proceed to a detailed assessment for 1,3 Butadiene.

Part 2.2: Detailed Assessment Method

After discussion with the Environment Agency, the refineries and the LAQM Review and Assessment Helpdesk it was decided that a further screening exercise rather than any specific modelling or monitoring for 1,3 Butadiene would initially be carried out for the detailed assessment. The Benzene monitoring and emissions inventory data will be used as a scaling tool to assess whether the Air Quality Objective for 1,3 Butadiene is likely to be breached. Monitoring (via diffusion tubes) will follow this if it is deemed necessary. Thus a brief overview of the Benzene emissions from the refineries and the monitoring carried out is given in Part 2.3.

Part 2.3: Benzene

As a result of the Updating and Screening Assessment 2003 North Lincolnshire Council proceeded to a detailed assessment for Benzene in the Scunthorpe and Killingholme areas. This consisted of a diffusion tube survey that ran between 27th November 2003 and 25th November 2004 at sensitive receptor sites near the refineries and along the boundaries of the installations.

At sensitive receptor sites the annual mean recorded was between 0.86 and 2.09 $\mu\text{g m}^{-3}$. It was concluded that there was no likelihood of the 2010 Air Quality Objective (5 $\mu\text{g m}^{-3}$) being breached.

The new methodology for measuring 1,3 Butadiene was also applicable to Benzene, thus resulting in higher reported emissions of Benzene in 2004 (and 2005) compared to previous years. As the Benzene monitoring took place during the first year of the new methodology for calculating emissions it was not necessary to proceed to another detailed assessment for Benzene.

The annual mass emissions of Benzene from the two refineries for 2000 to 2005 are shown in Table 2.2. For reference a description of the tube locations is given in Table A2. The annual mean concentrations of Benzene from the monitoring programme are shown in Figure A1 at the locations where they were recorded, this data is also shown in Table A3 for the sensitive receptor sites.

Type of process	Operator	Auth Ref	Receptor distance	Benzene Mass Emission, Tonnes, by Year					
				2000	2001	2002	2003	2004	2005
Gasification & Refining	Conoco Phillips Ltd, Humber Refinery	AF8173	840m	140	90	99	105	319	312
Gasification & Refining	Total UK Ltd Oil Refinery	AF6928	840m	91	82	88	76	127	117

Table 2.2: The mass of Benzene emissions from the two refineries between 2000 and 2005.

Part 2.4: Calculations

Part 2.4.1: Background and Road Traffic Contribution

As part of the Updating and Screening Assessment the DMRB (Design Manual for Roads and Bridges) screening tool is used to estimate concentrations of pollutants due to road traffic. The high number of Heavy Duty Vehicles using the Humber Road (A160) that runs past South Killingholme meant that a DMRB exercise was necessary.

The run location for the DMRB is shown in Figure A4 with the inputs and results of the run shown in Tables A5 and A6 respectively.

The DMRB indicates that the concentration of 1,3 Butadiene due to the background concentration and local road traffic is $0.3927 \mu\text{g m}^{-3}$. This is composed of a background component of $0.119 \mu\text{g m}^{-3}$ (obtained from the Air Quality Archive) and a traffic related component of $0.2737 \mu\text{g m}^{-3}$. In terms of the detailed assessment, this is a worst-case scenario as the calculations are based on a receptor distance of 10 metres from the road.

Part 2.4.2: Refineries Contribution

1. Worst Case Scenario

For this calculation the highest monthly Benzene concentration at a boundary location from the monitoring survey has been used. This was recorded by tube 23 (Conoco Boundary, Pumping Street entrance, Humber Road, South Killingholme) in February 2004 with a concentration of $14.3 \mu\text{g m}^{-3}$.

The total Benzene emission from the two refineries in 2004 was 446 tonnes. In this scenario the assumption is made that all the Benzene detected originated from the refineries:

$14.3 \mu\text{g m}^{-3} / 446 \text{ tonnes of emissions} = 0.03206 \mu\text{g m}^{-3}$ of Benzene per tonne of emission.

In 2004 the 1,3 Butadiene emissions of the refineries were slightly higher than in 2005 with a total of 24 tonnes. Thus the projected concentration of 1,3 Butadiene due to the refineries is:

$24 \text{ tonnes of 1,3 Butadiene} * 0.03206 \mu\text{g m}^{-3} \text{ per tonne of emission} = 0.7695 \mu\text{g m}^{-3}$.

In addition to this is the DMRB value for the background and traffic contribution, $0.3927 \mu\text{g m}^{-3}$, thus giving a total concentration of 1,3 Butadiene of $1.16 \mu\text{g m}^{-3}$. This concentration is equal to 51.65% of the Air Quality Objective.

There are no lower or upper assessment thresholds set out in the Regulations for 1,3 Butadiene, but the Lower and Upper Assessment thresholds for Benzene are 40% and 70% of the limit value. If these thresholds are applied

to 1,3 Butadiene this would equal a concentration of $0.9 \mu\text{g m}^{-3}$ for the lower assessment threshold and $1.575 \mu\text{g m}^{-3}$ for the upper assessment threshold. This scenario gives a result that is greater than the lower assessment threshold but is significantly lower than the upper assessment threshold.

2. Worst Case Receptor Scenario

The highest monthly Benzene concentration recorded at a sensitive receptor was $5.85 \mu\text{g m}^{-3}$; this was recorded in December 2003 by tube 16. This tube was located at Brick Lane in East Halton (TA 1451 1879) in a sensitive receptor location. In the original report it was thought that this tube could have been mixed up with tube 19, however, for this report this does not matter, as the location for this tube was also a sensitive receptor. This monthly concentration will be used as a worst-case scenario for a receptor location, with the same calculations carried out as those in scenario 1. Again it is assumed that all the Benzene detected has originated from the refineries.

$5.85 \mu\text{g m}^{-3} / 446 \text{ tonnes} = 0.01312 \mu\text{g m}^{-3}$ per tonne of emission.

Therefore the projected concentration of 1,3 Butadiene due to the refineries is equal to: $0.01312 * 24 = 0.3148 \mu\text{g m}^{-3}$.

Thus the total concentration of 1,3 Butadiene is calculated to be:
 $0.3148 \mu\text{g m}^{-3} + 0.3927 \mu\text{g m}^{-3}$ (background and traffic) = $0.7075 \mu\text{g m}^{-3}$.

This is equal to 31.44% of the Air Quality Objective; this is greater than half the lower assessment threshold.

3. Realistic Receptor Scenario

In the first and second scenarios it has been assumed that all of the Benzene detected originated from the refineries. However, for the Benzene survey a tube was located in Wrawby, near Brigg, to record a background concentration away from the influence of major roads and industry. The annual mean concentration of Benzene from this tube was $1.02 \mu\text{g m}^{-3}$.

For reference, one tube was located next to the A180 (dual carriageway) so that the contribution by road traffic could be calculated; an annual mean concentration of $1.06 \mu\text{g m}^{-3}$ was recorded. This means that $0.04 \mu\text{g m}^{-3}$ could be source apportioned to road traffic, this value similar to the DMRB result for Benzene from the A160 ($0.05 \mu\text{g m}^{-3}$).

The highest annual mean recorded at a sensitive receptor during the Benzene diffusion tube survey was $2.09 \mu\text{g m}^{-3}$. Thus if the measured background concentration is taken in addition to the DMRB result for the A160, this gives a non-refinery contribution of $1.07 \mu\text{g m}^{-3}$. This means that the refineries were responsible for $1.02 \mu\text{g m}^{-3}$ of the Benzene measured. Therefore if the same calculations are performed as those in scenarios 1 and 2, then:

$1.02 / 446 = 0.00287 \mu\text{g m}^{-3}$ per tonne of emission.

Therefore the projected concentration of 1,3 Butadiene due to refineries is equal to: $0.00287 * 24 = 0.0549 \mu\text{g m}^{-3}$.

The total concentration is thus: $0.0549 + 0.3927$ (background and traffic) = $0.4476 \mu\text{g m}^{-3}$.

This is equal to 19.89% of the Air Quality Objective for 1,3 Butadiene. This is less than the lower assessment threshold divided by 2 (20% or $0.45 \mu\text{g m}^{-3}$). By source this means that the percentage contributions can be allocated as follows:

- The refineries contribute 12.27% of the 1,3 butadiene present,
- 'Background' sources are responsible for 26.59%,
- And traffic is responsible for 61.15% of the 1,3 butadiene present.

Part 2.5: 1,3 Butadiene Conclusion

In conclusion the calculations in this report show that it is extremely unlikely that the Air Quality Objective for 1,3 Butadiene is being breached around the Killingholme refineries. In the first scenario, the 1,3 Butadiene concentration reaches 51% of the Objective. However, several assumptions are made that are likely to be unrealistic but were used to demonstrate the highest potential concentration.

In the third scenario (realistic receptor) the projected concentration is 19.9% of the Objective. This result is less than the value of the lower assessment threshold divided by two (20% = $0.45 \mu\text{g m}^{-3}$). However, even this is likely to be an over-estimate as the DMRB run was based on a receptor distance of 10 m, where as the majority of the receptors (relevant to an annual mean) are slightly further from the road than this. It is also clear that road traffic is a more significant contributor to 1,3 Butadiene concentrations than the refineries for receptors that are close to the road. Thus North Lincolnshire Council will not proceed to any modelling or detailed monitoring of 1,3 Butadiene in the Killingholme area at this time.