

**North Lincolnshire Council**

**Detailed Assessment of Benzene June 2005**

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## **Executive Summary**

The Updating & Screening Assessment (USA) for Air Quality produced by North Lincolnshire Council in May 2003 identified that there was the potential for the 2010 air quality objective for benzene to be exceeded at relevant locations.

The air quality objective for Benzene is  $5\mu\text{g}/\text{m}^3$  expressed as a running annual mean.

Relevant locations are those areas where the public might reasonably be exposed to a pollutant over its averaging time and can differ for each pollutant according to the averaging period considered. For long averaging times, such as an annual mean, relevant locations could include schools, houses, hospitals etc.

Two areas within North Lincolnshire were identified with the potential to exceed the 2010 objective namely Scunthorpe and Killingholme. Five Integrated Pollution Prevention and Control/Integrated Pollution Control (IPPC/IPC) installations operating within North Lincolnshire were identified for further consideration in the detailed assessment due to their annual mass emission of Benzene.

In order to quantify the annual mean benzene concentration in each location and consequently the areas that may exceed the 2010 objective a detailed assessment was undertaken involving a 12 month monitoring exercise.

The annual mean of benzene concentrations at relevant locations did not exceed the 2010 objective, although at one location at Santon, Scunthorpe some monthly concentrations did exceed  $5\mu\text{g}/\text{m}^3$  and consequently further investigation will be required. The monthly concentrations at certain boundary locations were greater than  $5\mu\text{g}/\text{m}^3$  at installations in Scunthorpe and Killingholme, however where there are no relevant receptors and exposure is unlikely to effect human health, no further investigation is required in relation to air quality assessment.

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## 1.0 Introduction

The following installations were identified in the Updating and Screening Assessment (USA) as being the significant sources of benzene within North Lincolnshire. The sites are regulated by the Environment Agency under the Environmental Protection Act 1990, Part 1 or the Pollution Prevention and Control Act 1999 as Part A/Part A(1) processes. Reference was made in the Updating & Screening Assessment to benzene emissions inventory data for the year 2000, the table below has been updated to the years 2002 and 2003.

**Table 1. Data from the Environment Agency Pollution Inventory**

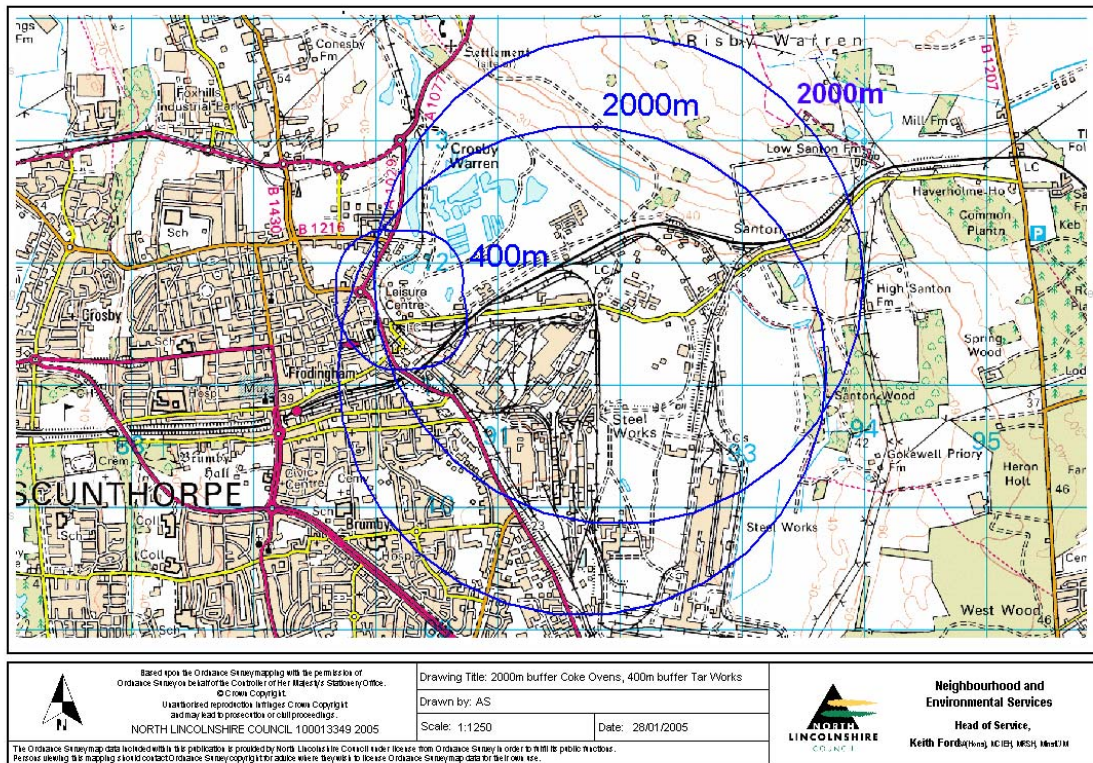
Type of process	Operator	Auth Ref	Mass emission (T) Year 2000	Mass emission (T) Year 2002	Mass emission (T) Year 2003
Appleby Coke ovens	Corus UK Ltd	AF7193	16	15.5	16.5
Dawes Lane Coke ovens	Corus UK Ltd	AF7193	16	15.5	16.5
Tar/bitumen distillation	Koppers Ltd	AU8296	1.45	<1	<1
Petroleum refinery	Conoco Phillips Ltd	AF8173	140	99	105
Petroleum refinery	Total UK Lindsey Oil	AF6928	91	88	76

In the USA the mass emission of benzene from each installation was compared against the nomograms for 2003 and 2010 respectively in accordance with Technical Guidance note LAQM TG(03). The nomograms estimate the distance from the source of benzene emission within which relevant receptors might be exposed to levels of benzene in excess of the objective. The definitions and guidance as to what constitutes a relevant receptor for the purposes as air quality management are contained in Appendix 6.

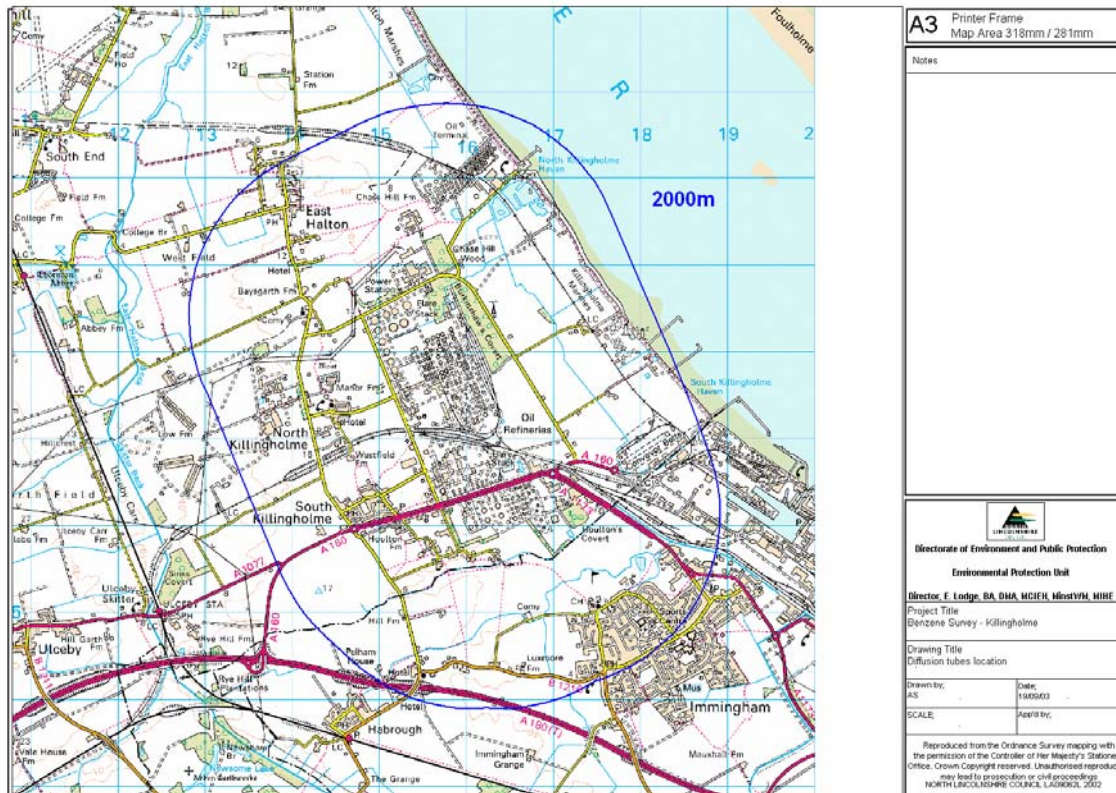
In relation to Scunthorpe sensitive dwellings located within a radius of 2000m from each coke oven battery may be exposed to levels above the objective, and similarly any sensitive dwelling within 400m from the Tar works.

Emissions of benzene from each installation were regarded as fugitive emissions because they are emitted at either a low level, low velocity or not from a source where emissions are fully contained and discharged through a stack. The zones of possible exceedence are identified in Figures 1.

**Figure 1. Zones of possible Benzene Exceedence in Scunthorpe**



**Figure 2. Zones of possible Benzene Exceedence in Killingholme**



In relation to Killingholme, the refineries are large-scale installations, with fugitive benzene emissions from the processing of petroleum and storage of petroleum products. As individual sources are difficult to pin point, sensitive dwellings up to 2000m from the installation boundary were considered to be within the area where a potential breach of the objective might occur. These dwellings are shown on Figure 2.

## **2.0 Monitoring Programme**

In order to determine concentrations of benzene in ambient air at the relevant receptors identified in Figures 1 & 2 a twelve-month monitoring programme was undertaken. This commenced on 27th November 2003 and finished on 25th November 2004. In conjunction, a monitoring exercise was also undertaken to determine the concentration of benzene at the boundary of some of the installations. It was anticipated that these results would be used to identify what benzene levels were close to the installation and the effect of dispersion over distance from the source on the reduction of benzene concentrations in ambient air.

Weather data collected at Killingholme Primary School, and a site in Scunthorpe was also used to determine the frequency of wind direction local to the installations.

The monitoring programme consisted of 49 chromosorb diffusion tubes (plus one unexposed tube utilised as a control). Each tube was exposed for a period of one month, this was then repeated for a 12 month duration. Each location was given an identification number 1-50 (50 being the control tube).

### **2.1 Site Locations Killingholme**

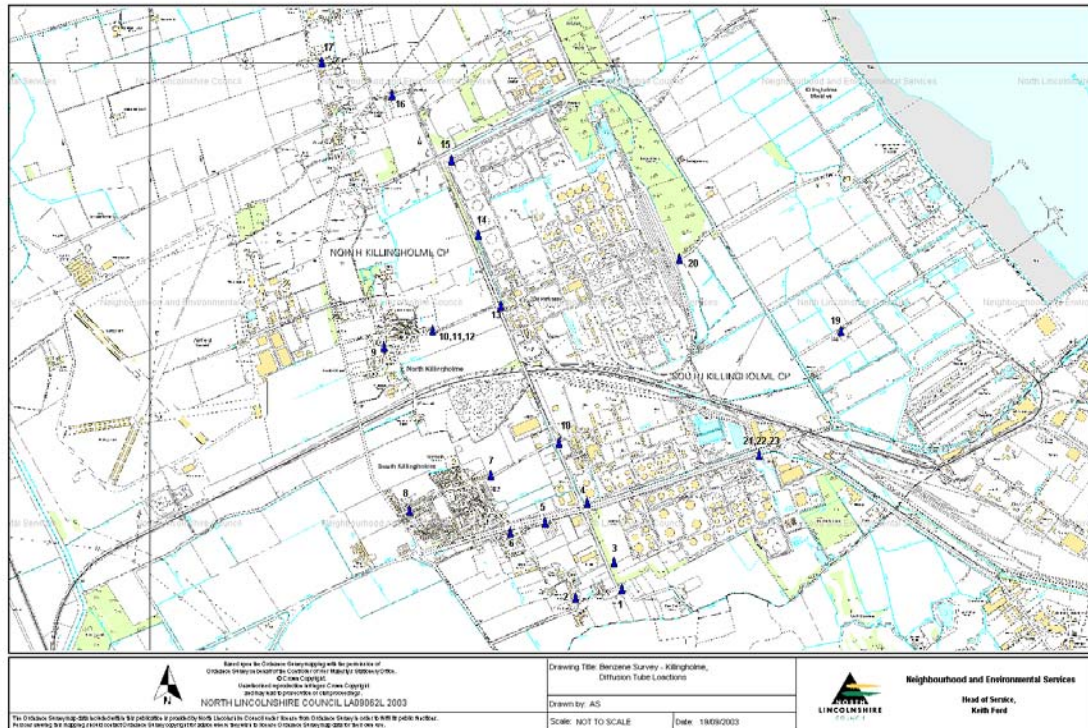
A total of 23 diffusion tubes were located in the Killingholme area at the following location types: -

Relevant receptors in South Killingholme village	6
Relevant receptors in North Killingholme village	4
Relevant receptors in East Halton village	2
Refinery installation boundary	10
Relevant receptors to the west of the refineries	1

In order to check the consistency of the measurement technique three diffusion tubes were co-located i.e. placed together at the same location. A co-location exercise was conducted at one boundary installation site and one relevant receptor site. It was anticipated that confidence in the results obtained would be improved if the co-located tubes showed consistent readings. Co-locations were chosen for areas where both low and high concentrations of benzene could be expected.



**Figure 3. Location of benzene diffusion tubes - Killingholme**



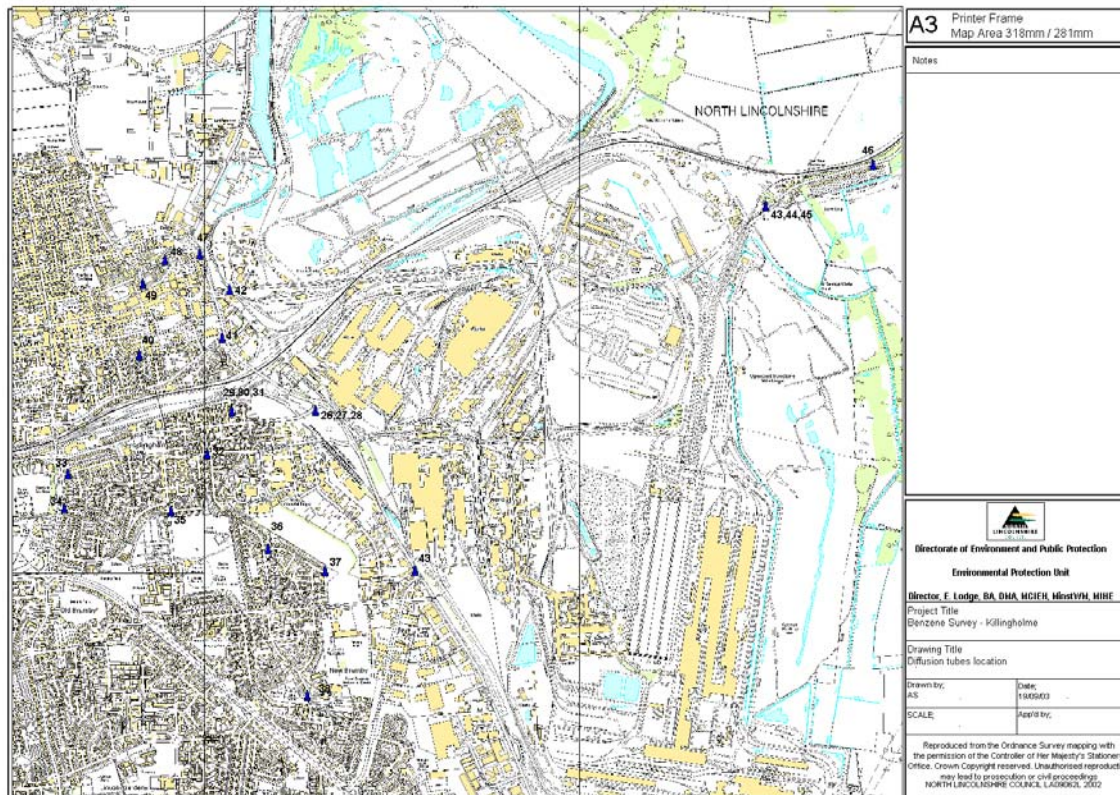
## 2.2 Site Locations Scunthorpe

A total of 24 diffusion tubes were located in and around Scunthorpe at the following location types: -

Relevant receptors in Scunthorpe	14
Relevant receptors in Santon village	4
Installation boundaries	5
Industrial and traffic	1

As with the Killingholme survey three diffusion tubes were co-located at a relevant receptor site in Scunthorpe, a boundary location and a relevant receptor in Santon. Santon is to the west of the industrial source of benzene.

**Figure 4. Location of benzene diffusion tubes - Scunthorpe**



## **2.3 Site Location Background**

A diffusion tube was also located in Wrawby village near Brigg, this location was designed to represent background concentrations of benzene at relevant receptors when no major industrial or traffic sources exist to contribute to elevated levels of benzene.

## **2.4 Site Location Traffic**

A diffusion tube was also located on a lay-by on the A180, this was designed to quantify the extent to which road traffic contributes to measures values, the A180 is located a sufficient distance away from the refineries but has a similar traffic flow to the stretch of road close to the refinery.

**Table 2. Benzene diffusion tube locations – Killingholme**

<b>Tube No.</b>	<b>Monitoring Type</b>	<b>Location</b>	<b>Grid Ref</b>
1	Sensitive Receptor – Refinery Emissions	Eastfield Road/Baptist Chapel Lane (LP 7). South Killingholme	TA 15941568
2	Sensitive Receptor – Refinery Emissions	Faulding Lane/Baptist Chapel Lane (LP 27). South Killingholme	TA 15661563
3	Boundary Concentration	Eastfield Road, access track to Conoco. South Killingholme	TA 15901585
4	Boundary & Traffic Concentration	Conoco Boundary, Humber Road/Eastfield Road Junction. South Killingholme	TA 15731621
5	Sensitive Receptor – Refinery & Traffic Emissions	Humber Road (LP 59). South Killingholme	TA 15471610
6	Sensitive Receptor – Refinery & Traffic Emissions	Primitive Chapel Lane/ Humber Road (LP 2). South Killingholme	TA 15231602
7	Sensitive Receptor – Refinery Emissions	Staple Road (LP 3). South Killingholme	TA 15131640
8	Sensitive Receptor – Refinery Emissions	Greengate Road (LP 3). South Killingholme	TA 14621616
9	Sensitive Receptor – Refinery Emissions	Clarkes Road (LP 3). North Killingholme	TA 14461721
10	Sensitive Receptor – Refinery Emissions	Nicholson Road (LP 3). North Killingholme	TA 14761730
11	Sensitive Receptor – Refinery Emissions	Nicholson Road (LP 3). North Killingholme	Co-location
12	Sensitive Receptor – Refinery Emissions	Nicholson Road (LP 3). North Killingholme	Co-location
13	Boundary Concentration	LOR Boundary, Eastfield Road /Nicholson Road. North Killingholme	TA 15181747
14	Boundary Concentration	LOR Boundary, Eastfield Road. North Killingholme	TA 15041790
15	Boundary Concentration	LOR Boundary, Chase Hill Road /Eastfield Road. North Killingholme	TA 14881835
16	Sensitive Receptor – Refinery Emissions	Brick Lane. East Halton	TA 14511879
17	Sensitive Receptor – Refinery Emissions	Scrub Lane (LP 6). East Halton	TA 14071899
18	Boundary Concentration	Conoco Boundary, Eastfield Road /Staple Road (LP 16). Sth Killingholme	TA 15561659
19	Sensitive Receptor – Refinery Emissions	Hazel Dene, Marsh Lane. South Killingholme	TA 17321731
20	Boundary Concentration	LOR Boundary, Station Road /Rosper Road. Sth Killingholme	TA 16301776
21	Boundary Concentration	Conoco Boundary, Pumping St. entrance, Humber Road. Sth Killingholme	TA 16811652
22	Boundary Concentration	Conoco Boundary, Pumping St. entrance, Humber Road. Sth Killingholme	Co-location
23	Boundary Concentration	Conoco Boundary	Co-location

**Table 3. Benzene Diffusion tube locations - Scunthorpe**

26	Boundary Concentration	Corus Boundary, Brigg Road/ Rowland Road.	SE 90591088
27	"	"	"
28	"	"	"
29	Sensitive Receptor - Corus Emissions	Queens Street/Rowland Road. (LP 2)	SE 90141086
30	"	"	"
31	"	"	"
32	Sensitive Receptor - Corus Emissions	Cottage Beck Road/ Warwick Road (LP 23)	SE 90011063
33	Sensitive Receptor - Corus Emissions	Cottage Beck Road/Ashby Road. (LP 1).	SE 89271053
34	Background Concentration/ Scunthorpe Area	Ashby Road/Lydbrook (LP 9)	SE 89251035
35	Sensitive Receptor - Corus Emissions	Cemetery Road/Fairmont Crescent (LP 1).	SE 89821033
36	Sensitive Receptor - Corus Emissions	Warwick Road/Lilac Avenue (LP 5).	SE 90331013
37	Sensitive Receptor - Corus Emissions	Lilac Avenue (LP 12)	SE 90641001
38	Sensitive Receptor - Corus Emissions	Healey Road/Rutland Road (LP 17).	SE 90540935
39	Boundary Concentration	Corus Boundary, Brigg Road/Nr Grange Lane North (LP 90).	SE 91111003
40	Sensitive Receptor - Corus Emissions	Thompson Road/Station Road (LP 6).	SE 89641116
41	Industrial & Traffic Concentrations	Station Road/Brigg Road (LP 37)	SE 90091126
42	Boundary Concentrations	Koppers Boundary, High Street East/Dawes Lane (LP 6).	SE 90121152
43	Sensitive Receptors - Corus Emissions	Dawes Lane, Santon, Nr Corus Barrier	SE 92981195
44	Sensitive Receptors - Corus Emissions	Dawes Lane, Santon, Nr Corus Barrier	Co-location
45	Sensitive Receptors - Corus Emissions	Dawes Lane, Santon, Nr Corus Barrier	Co-location
46	Sensitive Receptors - Corus Emissions	Dawes Lane, Santon (LP 13) Opp House No. 32	SE 93541218
47	Sensitive Receptors - Koppers Emissions	Trafford Street/Cross Street (LP 7).	SE 89971170
48	Sensitive Receptors - Koppers Emissions	Kings Court/Chapel Street (LP 37).	SE 89781167
49	Sensitive Receptors - Koppers Emissions	Crosby Road/Chapel Street (LP 2).	SE 89661155



**Table 3. Benzene diffusion tubes - Traffic, background and control.**

24	Traffic/Background Concentrations	3 <sup>rd</sup> Layby A180 (W)	TA 10121334
25	North Lincolnshire background Concentration	Kettleby Lane, Wrawby, Nr Brigg	TA02370842
50	CONTROL TUBE	Not exposed to ambient air	N/A

If possible the tubes were attached to lampposts or the boundary fence of the nearby industrial installation. The chosen lampposts were sited as close as possible to relevant receptors, typically residential dwellings. For the background measurement, the diffusion tube was situated approximately 320m away from the A18, greater than the minimum 100m from a major road recommended for background measurements.

The diffusion tubes were attached to the lampposts on metal brackets, the tubes were greater than 5cm away from the vertical surface of the lamppost. The tubes were mounted vertically with the sampling end downwards. All tubes with the exception of number 24 (lay-by on A180) were located at least 1.5m above ground, typically the tubes in residential areas were located out of arms reach, no tube was positioned greater than 2.5m above ground.

### **3.0 Monitoring Strategy / Analysis**

Fifty diffusion tubes were received from the laboratory at the end of each month and put in their monitoring locations on a predetermined date. The diffusion tubes had their own unique identification number used for reference by the laboratory. A written procedure was implemented for assigning and recording the reference identification and corresponding location number for each tube at every location prior to mounting on site.

On the day of tube change over the exposed tubes were collected and the replacement tube put out for exposure. The start and finish time of each tube exposure period was recorded. The collected tubes were sent to the laboratory for analysis accompanied by the chain of custody sheet detailing the exposure time for each tube reference number.

A report was sent by the laboratory 10-14 days after receipt of the diffusion tubes stating the total benzene measured during the desorption process, expressed in nanogrammes (ng) and the corresponding concentration of benzene for each tube in parts per billion (ppb). The concentrations for each tube reference number were then cross referenced to the tube location numbers. This gave a value for monthly benzene concentration at a given location.

The criteria used to select the laboratory to supply and analyse the diffusion tubes, included UKAS accreditation and membership of the WASP (Workplace Analysis Scheme for Proficiency) scheme. The laboratory selected for supply and analysis was Harwell Scientifics.

The analysis method of the chromosorb tubes for benzene was thermal desorption - gas chromatography - mass spectrometry. The results obtained from the analysis were used in conjunction with the sampling times (time exposed to ambient air) to produce the concentration data in ppb for each sampling location.

The analysis data provided by the laboratory expressed the results as the total amount of benzene on each tube in ng, and the concentration of benzene for each sample in ppb. This was calculated using the known exposure times and the uptake rate obtained from the Health and Safety Executive/CAR/Working group 5 compilation for Perkin Elmer tubes (reference: The Diffusive Monitor, July 2001, Issue 12). The limit of detection for analysis of benzene was 0.07ppb.

The benzene concentrations at each location are expressed in  $\mu\text{g}/\text{m}^3$ , this is the concentration in ppb multiplied by a factor of 3.25. The 3.25 factor was taken from the Technical Guidance note LAQM.TG(03).

Where tubes were co-located at a monitoring site, the maximum value of all three tubes was used for each month to determine the annual mean. The maximum monthly value was used to represent the worst-case scenario.

For certain months data is unavailable for some locations, due to either the loss of the diffusion tube whilst monitoring, or on some occasions contamination of the tube resulting in unsuccessful analysis. In addition some analysis results were received detailing benzene concentration of  $0.20\mu\text{g}/\text{m}^3$ , i.e. equivalent to the unexposed control tube, these results were therefore omitted from calculation of the annual mean due to the possibility that the levels were inaccurate due to monitoring errors.

## 4.0 Results

**Table 4. Killingholme Results – Annual mean at relevant receptors**

Location Number	Location address	Annual Mean concentration of benzene $\mu\text{g}/\text{m}^3$	% Data used
1	Eastfield Road/Baptist Chapel Lane (LP 7). South Killingholme	1.43	100
2	Faulding Lane/Baptist Chapel Lane (LP 27). South Killingholme	1.36	92
5	Humber Road (LP 59). South Killingholme	1.46	100
6	Primitive Chapel Lane/ Humber Road (LP 2). South Killingholme	1.18	92
7	Staple Road (LP 3). South Killingholme	1.17	92
8	Greengate Road (LP 3). South Killingholme	1.11	83
9	Clarkes Road (LP 3). North Killingholme	0.86	92
10,11,12	Nicholson Road (LP 3). North Killingholme	1.36	100
16	Brick Lane. East Halton	1.46	100
17	Scrub Lane (LP 6). East Halton	1.07	100
19	Hazel Dene, Marsh Lane. South Killingholme	2.09	92

**Table 5. Killingholme Results – Annual mean concentration at boundary locations**

Location Number	Location address	Annual Mean concentration of benzene $\mu\text{g}/\text{m}^3$	% Data used
3	Eastfield Road, access track to Conoco. South Killingholme	2.66	75
4	Conoco Boundary, Humber Road/Eastfield Road Junction. South Killingholme	3.57	100
13	LOR Boundary, Eastfield Road/Nicholson Road. North Killingholme	1.99	83
14	LOR Boundary, Eastfield Road. North Killingholme	2.69	92
15	LOR Boundary, Chase Hill Road/Eastfield Road. North Killingholme	1.44	100
18	Conoco Boundary, Eastfield Road/Staple Road (LP 16). South Killingholme	3.95	100
20	LOR Boundary, Station Road/Rosper Road. South Killingholme	3.02	83
21,22,23	Conoco Boundary, Pumping St. entrance, Humber Road. South Killingholme	6.54	100



**Table 6 Scunthorpe Results – Annual mean at relevant receptors**

<b>Location Number</b>	<b>Location address</b>	<b>Annual Mean concentration of benzene <math>\mu\text{g}/\text{m}^3</math></b>	<b>% Data used</b>
29,30,31	Queens Street/Rowland Road. (LP 2)	1.80	100
32	Cottage Beck Road/ Warwick Road (LP 23)	1.93	100
33	Cottage Beck Road/Ashby Road. (LP 1).	1.89	100
34	Ashby Road/Lydbrook (LP 9)	1.57	100
35	Cemetery Road/Fairmont Crescent (LP 1).	1.37	75
36	Warwick Road/Lilac Avenue (LP 5).	1.39	92
37	Lilac Avenue (LP 12)	1.50	83
38	Healey Road/Rutland Road (LP 17).	1.08	67
40	Thompson Road/Station Road (LP 6).	1.31	100
43	Dawes Lane, Santon, Nr Corus Barrier	3.39	100
46	Dawes Lane, Santon (LP 13) Opp House No. 32	2.09	92
47	Trafford Street/Cross Street (LP 7).	2.74	92
48	Kings Court/Chapel Street (LP 37).	1.65	92
49	Crosby Road/Chapel Street (LP 2).	1.55	92

**Table 7 Scunthorpe Results – Annual mean concentration at boundary locations**

26	Corus Boundary, Brigg Road/ Rowland Road.	2.12	100
39	Corus Boundary, Brigg Road/Nr Grange Lane North (LP 90).	2.31	100
41	Station Road/Brigg Road (LP 37)	1.91	100
42	Koppers Boundary, High Street East/Dawes Lane (LP 6).	2.61	100

**Table 8 Background and traffic results & control tube**

24	3 <sup>rd</sup> Layby A180 (W)	1.06	67
25	Kettleby Lane, Wrawby, Nr Brigg	1.02	100
50	CONTROL not exposed to ambient air	0.22	100

## 5.0 Benzene Concentrations & Weather Data

Where the monthly concentration of benzene at a location exceeded  $4\mu\text{g}/\text{m}^3$  (i.e.  $5\mu\text{g}/\text{m}^3 \pm 20\%$ ), further analysis of weather data was undertaken. Initially wind direction was examined for the relevant months with a view to conducting further investigation where the annual mean at a location was greater than  $4\mu\text{g}/\text{m}^3$ . The weather data for Killingholme is 15-minute averages of wind direction (in degrees), Scunthorpe wind direction data is 10 minute averages.

The raw data was converted into a percentage of occurrences at  $10^\circ$  intervals and was plotted as wind roses for each month of the benzene survey. Each location was identified where the monthly concentration was greater than  $4\mu\text{g}/\text{m}^3$ , the next stage involved identifying the direction of the benzene sources from each monitoring location in degrees. Typically this was the installation boundary for most benzene sources, although in Scunthorpe the direction of the coke ovens, as a point source from the monitoring location, was used. The percentage of time the wind was between these directions was calculated.

The accuracy of the wind direction data is unknown as the calibration and service history of the weather masts is unknown, therefore this data only offers an indication of wind direction. Due to the fact that the annual mean was not greater than  $4\mu\text{g}/\text{m}^3$  at any locations no further investigation of weather data is required, with the exception of locations in Santon where further benzene monitoring is to be undertaken, the weather data for this exercise will be taken from a weather mast subsequently installed in Scunthorpe.

Tables 9 and 10 below show wind direction data, the analysis is designed to be indicative of the contributing sources to elevated concentrations of benzene.

**Table 9 – Benzene Concentrations & Wind Direction in Killingholme**

Tube ID	Direction of source from sampling location (degrees)	% Wind from this direction
<b>December 2003</b>		
4	0-140	20
20	210-310	62
21,22,23	210-310	62
<b>January 2004</b>		
20	210-310	74
21,22,23	210-310	74
<b>February 2004</b>		
3	330-80	33
4	0-140	16
14	0-160	16
21,22,23	210-310	54
18	0-160	16

<b>March 2004</b>		
4	0-140	33
21,22,23	210-310	46
Tube ID	Direction of source from sampling location (degrees)	% Wind from this direction
<b>April 2004</b>		
4	0-140	27
18	0-160	32
<b>May 2004</b>		
3	330-80	41
4	0-140	35
21,22,23	210-310	33
<b>June 2004</b>		
21,22,23	210-310	56
<b>July 2004</b>		
4	0-140	20
21,22,23	210-310	51
<b>August 2004</b>		
14	0-160	46
18	0-160	46
21,22,23	210-310	35
<b>September 2004</b>		
None		
<b>October 2004</b>		
18	0-160	40
<b>November 2004</b>		
21,22,23	210-310	68

**Table 10 – Benzene Concentrations & Wind Direction in Scunthorpe**

Tube ID	Direction of source from sampling location (degrees)	% Wind from this direction
<b>December 2003</b>		
39	0-80	17
41	0-110	26
42	0-110	26
43,44,45	220-260	24
<b>January 2004</b>		
43,44,45	220-260	35
<b>February 2004</b>		
29,30,31	0-90	17
<b>September 2004</b>		
46	220-260	38
<b>November 2004</b>		
43,44,45	220-260	No data



## **6.0 Conclusion**

### **6.1 Air Quality – Killingholme**

The results from the 12-month monitoring exercise suggest that the 2010 air quality objective is unlikely to be breached at relevant receptors in and around Killingholme.

The annual mean concentrations of benzene recorded range between 0.86-2.09  $\mu\text{g}/\text{m}^3$  compared with a recorded general background concentration for benzene of 1.02  $\mu\text{g}/\text{m}^3$ . No monthly benzene concentrations at relevant receptors exceeded 4  $\mu\text{g}/\text{m}^3$ , with the exception of location number 16 in December 2003. It is possible that this particular diffusion tube result was confused with location number 19 by the laboratory. (See Appendix 3 for monthly tube concentrations).

The annual mean for boundary concentrations of benzene range from 1.44  $\mu\text{g}/\text{m}^3$  towards the Northern edge of the installations, to 6.54  $\mu\text{g}/\text{m}^3$  towards the South-East of the installations.

The maximum monthly concentration at any boundary location was 14.30  $\mu\text{g}/\text{m}^3$ . Although this value was taken from a boundary location rather than a relevant receptor it is still less than the existing air quality objective for 2003 that allows an annual mean of 16.25  $\mu\text{g}/\text{m}^3$ .

It is concluded that there is no likelihood that the 2010 air quality objective for Benzene will be breached and therefore it is proposed that no further monitoring in the Killingholme area is undertaken unless there is a significant increase in the actual mass emission of benzene from any of the relevant installations in the locality. The reported mass emission of benzene from petroleum processing installations may show an increase due to a new methodology for calculating emissions.

### **6.2 Air Quality – Scunthorpe**

The results from the 12-month monitoring exercise suggest that the 2010 air quality objective could potentially be breached at relevant receptors along Dawes Lane in Santon village. It is important to note however that at most relevant receptors in and around the Scunthorpe area the 2010 objective is likely to be achieved.

The monthly concentrations of benzene recorded range between 1.43 - 6.50  $\mu\text{g}/\text{m}^3$  at the location in Santon with an annual mean of 3.39  $\mu\text{g}/\text{m}^3$ . Four of the monthly concentrations at this location were above 4  $\mu\text{g}/\text{m}^3$ , these were observed in December 2003, January, February and November 2004.

The annual mean concentrations of benzene recorded at the remaining locations in around Scunthorpe range between 1.08 - 2.74  $\mu\text{g}/\text{m}^3$  compared against a recorded general background concentration for benzene of 1.02 $\mu\text{g}/\text{m}^3$ .

None of the monthly benzene concentrations at relevant receptors exceeded 4 $\mu\text{g}/\text{m}^3$ , with the exception of location numbers 29, 30 & 31 (co-located) in February 2004, and location number 46 in September 2004. (See Appendix 3 for monthly tube concentrations).

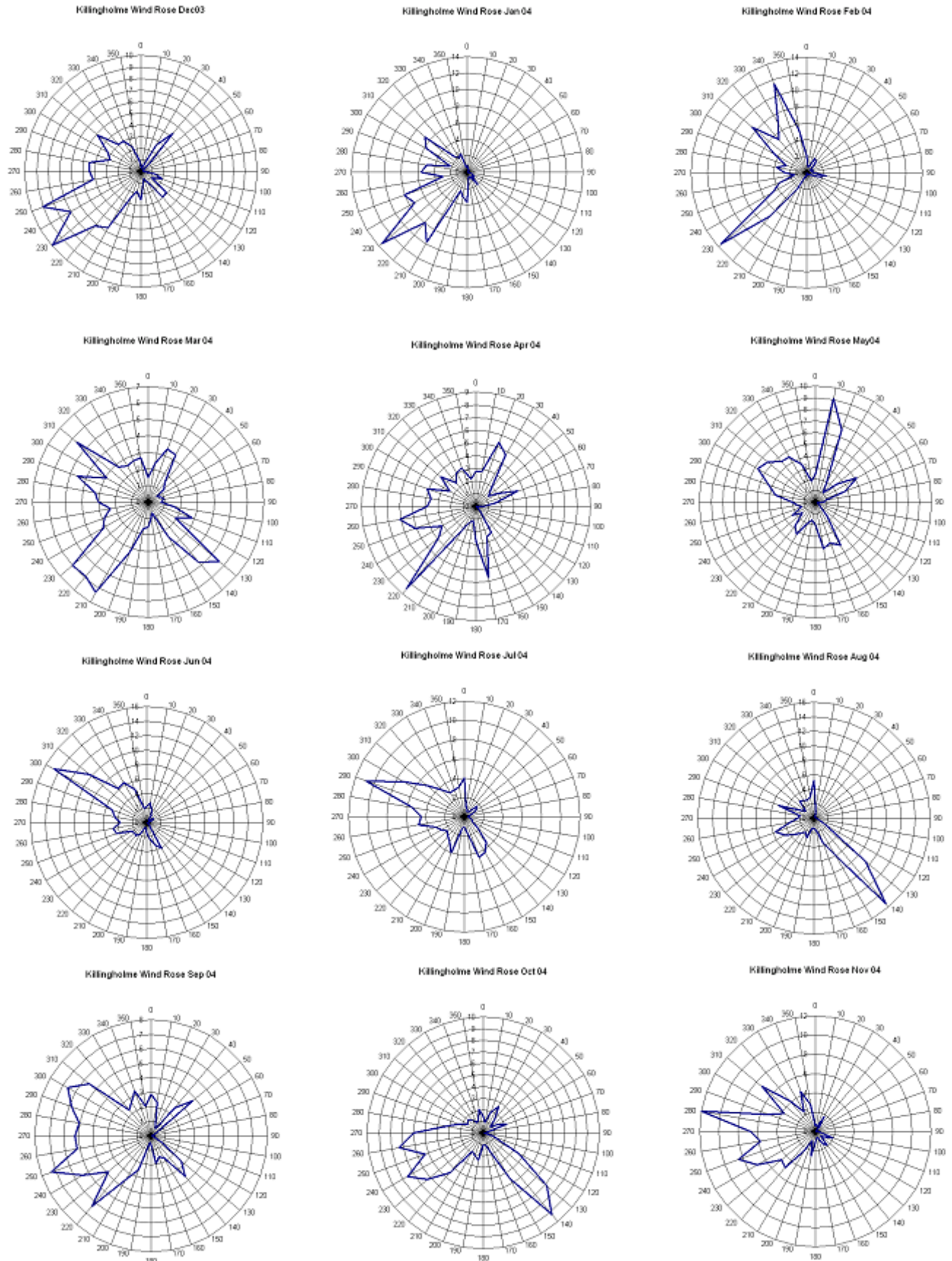
The annual means for boundary concentrations of benzene range from 1.91 $\mu\text{g}/\text{m}^3$  – 2.61 $\mu\text{g}/\text{m}^3$ , at locations situated towards the West of the emissions source. The location in Santon Village has been treated as a location for relevant receptors although it is also situated on an installation boundary.

The maximum monthly concentration at any boundary location was 6.50 $\mu\text{g}/\text{m}^3$ . This value was taken from a boundary location, which is also a relevant receptor however it is still less than the existing air quality objective for 2003 with an annual mean of 16.25 $\mu\text{g}/\text{m}^3$ .

It is proposed that further monitoring for benzene in Santon and Dawes Lane, Scunthorpe be undertaken at relevant receptors for a further period of 12 months.

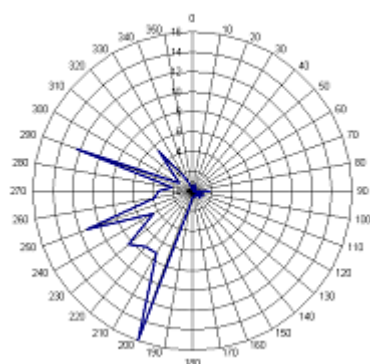
In addition information regarding the actual mass emissions from relevant installations will be reviewed annually, if there is a significant increase in the mass emission from any of the installations further monitoring will be undertaken at relevant receptors in Scunthorpe.

## Appendix 1 - Monthly Wind roses - Killingholme

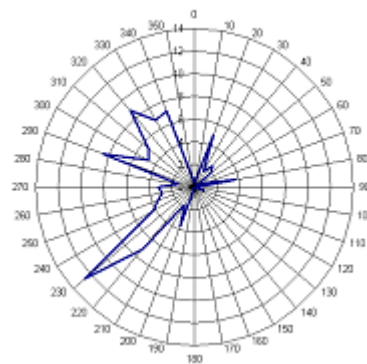


## **Appendix 2 - Monthly Wind roses - Scunthorpe**

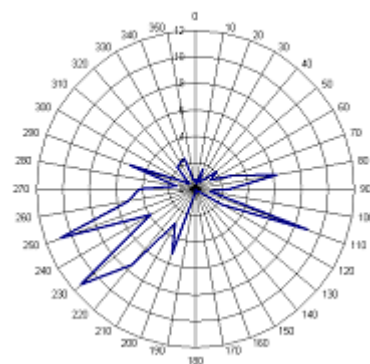
Scunthorpe Windrose Jan 04



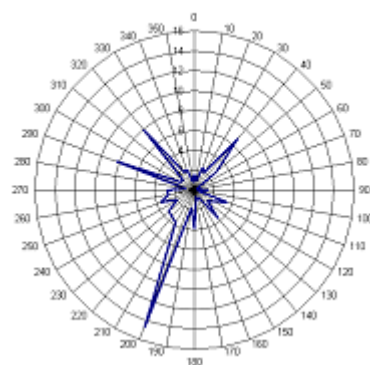
Scunthorpe Wind Rose- Feb 04



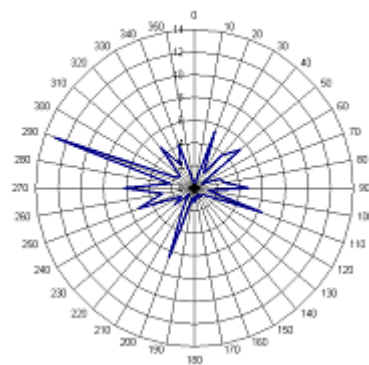
Scunthorpe Wind Rose Mar 04



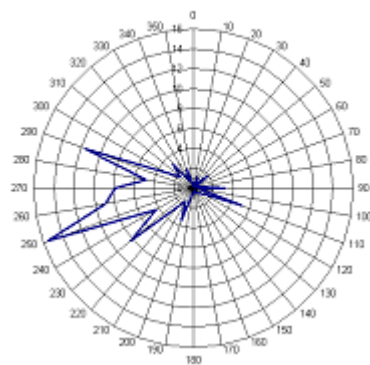
Scunthorpe Wind Rose Apr 04



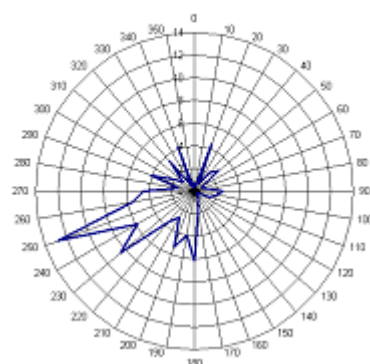
Scunthorpe Wind Rose May 04



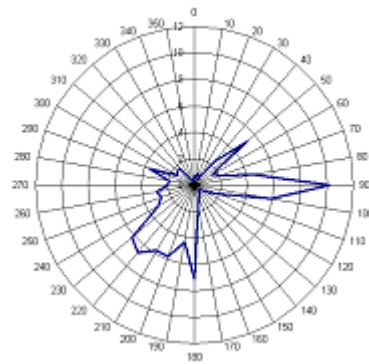
Scunthorpe Wind Rose Jun 04



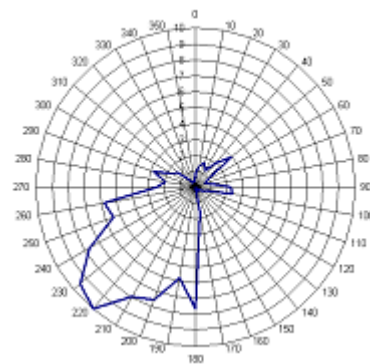
Scunthorpe Wind Rose Jul 04



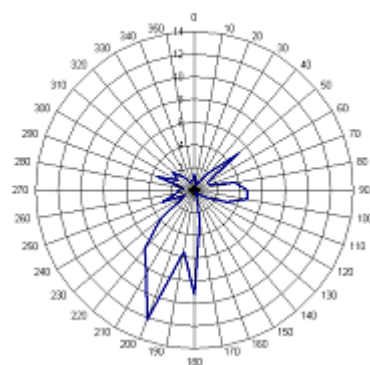
Scunthorpe Wind Rose Aug 04



Scunthorpe Wind Rose Sep 04



Scunthorpe Wind Rose Oct04



### Appendix 3 – Raw Data Dec 2003 – March 2004

TUBE ID	Dec-03		Jan-04		Feb-04		Mar-04	
	Ppb	ug/m3	ppb	ug/m3	ppb	ug/m3	ppb	ug/m3
1	0.49	1.59	0.51	1.66	0.77	2.50	0.64	2.08
2	0.43	1.40	0.44	1.43	0.58	1.89	0.49	1.59
3			0.67	2.18	1.70	5.53	0.99	3.22
4	1.80	5.85	0.68	2.21	2.30	7.48	1.4	4.55
5	0.80	2.60	0.45	1.46	0.93	3.02	0.62	2.02
6	0.54	1.76	0.46	1.50	0.82	2.67	0.52	1.69
7	0.34	1.11			0.75	2.44	0.49	1.59
8			0.41	1.33	0.73	2.37	0.55	1.79
9	0.10	0.33	0.41	1.33	0.44	1.43	0.36	1.17
10	0.61	1.98	0.48	1.56	0.55	1.79	0.43	1.40
11	0.49	1.59	0.35	1.14	0.50	1.63	0.41	1.33
12	0.49	1.59	0.46	1.50	0.55	1.79	0.26	0.85
13	0.69	2.24	0.47	1.53	1.10	3.58	0.71	2.31
14	0.72	2.34	0.50	1.63	1.50	4.88	1.1	3.58
15	0.40	1.30	0.35	1.14	0.45	1.46	0.5	1.63
16	1.80	5.85	0.45	1.46	0.32	1.04	0.34	1.11
17	0.29	0.94	0.42	1.37	0.37	1.20	0.61	1.98
18	0.78	2.54	0.76	2.47	1.30	4.23	1.1	3.58
19	0.55	1.79	0.77	2.50	1.10	3.58	0.76	2.47
20	1.30	4.23	1.70	5.53	1.30	4.23	0.94	3.06
21	0.32	1.04	2.70	8.78	0.71	2.31	2.3	7.48
22	1.60	5.20			3.60	11.70	2.2	7.15
23	1.80	5.85	2.70	8.78	4.40	14.30	2.1	6.83
24	0.52	1.69	0.42	1.37	0.41	1.33		
25	0.43	1.40	0.58	1.89	0.46	1.50	0.41	1.33
26	1.00	3.25	0.58	1.89	0.92	2.99	0.59	1.92
27	0.99	3.22	0.60	1.95	0.89	2.89	0.55	1.79
28	0.90	2.93	0.61	1.98	0.87	2.83	0.64	2.08
29	0.94	3.06	0.54	1.76	0.66	2.15	0.51	1.66
30	0.68	2.21	0.53	1.72	1.30	4.23	0.47	1.53
31	0.81	2.63	0.52	1.69	0.69	2.24	0.5	1.63
32	0.94	3.06	0.70	2.28	1.00	3.25	0.58	1.89
33	1.10	3.58	0.66	2.15	0.90	2.93	0.67	2.18
34	1.00	3.25	0.66	2.15	0.69	2.24	0.67	2.18
35	0.53	1.72	0.60	1.95	0.68	2.21	0.47	1.53
36	0.78	2.54			0.90	2.93	0.53	1.72
37	0.91	2.96	0.47	1.53	0.71	2.31	0.55	1.79
38	0.60	1.95	0.51	1.66				
39	1.60	5.20	0.67	2.18	1.10	3.58	0.91	2.96
40	0.53	1.72	0.47	1.53	0.58	1.89	0.47	1.53
41	1.40	4.55	0.68	2.21	0.87	2.83	0.27	0.88
42	1.30	4.23	0.68	2.21	1.50	4.88	0.81	2.63



43	1.10	3.58	1.60	5.20	1.30	4.23	0.95	3.09
44	1.50	4.88	2.00	6.50	1.00	3.25	0.93	3.02
45	1.50	4.88	1.80	5.85	1.20	3.90	1	3.25
46	0.66	2.15	1.10	3.58	0.85	2.76	0.69	2.24
47	1.10	3.58	0.61	1.98	1.10	3.58	1	3.25
48	0.91	2.96	0.34	1.11	0.55	1.79	0.72	2.34
49	0.94	3.06	0.47	1.53	0.58	1.89	0.57	1.85
50	0.08	0.26	0.06	0.20	0.07	0.23	0.07	0.23

**Appendix 3 Continued – Raw Data Apr 2003 – July 2004**

TUBE ID	Apr-04		May-04		June-04		Jul-04	
	Ppb	ug/m3	ppb	ug/m3	ppb	ug/m3	ppb	ug/m3
1	0.71	2.31	0.60	1.95	0.17	0.55	0.27	0.88
2	0.46	1.50	0.50	1.63			0.13	0.42
3	1.10	3.58	1.22	3.97				
4	1.20	3.90	1.39	4.52	0.42	1.37	2.01	6.53
5	0.42	1.37	0.45	1.46	0.16	0.52	0.35	1.14
6			0.30	0.98	0.12	0.39	0.21	0.68
7	0.43	1.40	0.30	0.98	0.17	0.55	0.18	0.59
8	0.34	1.11	0.30	0.98	0.16	0.52	0.16	0.52
9	0.30	0.98	0.21	0.68	0.14	0.46	0.19	0.62
10	0.33	1.07	0.33	1.07	0.17	0.55	0.07	0.23
11	0.37	1.20	0.30	0.98			0.31	1.01
12	0.35	1.14	0.29	0.94	0.23	0.75	0.25	0.81
13	0.58	1.89	0.50	1.63			0.37	1.20
14			0.75	2.44	0.54	1.76	0.70	2.28
15	0.38	1.24	0.44	1.43	0.37	1.20	0.48	1.56
16	0.33	1.07	0.28	0.91	0.34	1.11	0.43	1.40
17	0.28	0.91	0.25	0.81	0.21	0.68	0.32	1.04
18	1.20	3.90	0.93	3.02	0.59	1.92	1.06	3.45
19	0.68	2.21	0.55	1.79	0.48	1.56	0.36	1.17
20	0.85	2.76	0.70	2.28	0.79	2.57		
21	1.00	3.25	1.51	4.91	1.95	6.34	3.04	9.88
22	1.00	3.25	1.57	5.10	1.64	5.33	2.03	6.60
23	1.00	3.25	1.53	4.97	1.11	3.61	0.41	1.33
24	0.25	0.81	0.43	1.40	0.19	0.62		
25	0.28	0.91	0.26	0.85	0.19	0.62	0.27	0.88
26	0.36	1.17	0.32	1.04	0.37	1.20	0.39	1.27
27	0.46	1.50	0.49	1.59	0.36	1.17	0.43	1.40
28	0.43	1.40	0.48	1.56	0.34	1.11	0.39	1.27
29			0.34	1.11	0.25	0.81	0.14	0.46
30	0.31	1.01	0.39	1.27	0.24	0.78	0.26	0.85
31	0.44	1.43	0.34	1.11	0.24	0.78	0.20	0.65
32	0.63	2.05	0.25	0.81	0.31	1.01	0.46	1.50
33	0.66	2.15	0.53	1.72	0.34	1.11	0.45	1.46
34	0.43	1.40	0.42	1.37	0.27	0.88	0.38	1.24
35			0.39	1.27	0.07	0.23	0.07	0.23
36	0.29	0.94	0.35	1.14	0.25	0.81	0.34	1.11
37	0.31	1.01	0.35	1.14	0.22	0.72	0.36	1.17
38			0.36	1.17	0.19	0.62	0.17	0.55
39	0.90	2.93	0.80	2.60	0.30	0.98	0.48	1.56
40	0.39	1.27	0.32	1.04	0.19	0.62	0.30	0.98
41	0.61	1.98	0.50	1.63	0.40	1.30	0.32	1.04
42	1.10	3.58	0.86	2.80	0.31	1.01	0.57	1.85

43	0.50	1.63	0.47	1.53	0.82	2.67	0.96	3.12
44	0.48	1.56	0.37	1.20	1.07	3.48	0.86	2.80
45	0.47	1.53	0.46	1.50	1.09	3.54	0.60	1.95
46	0.36	1.17	0.37	1.20	0.60	1.95	0.36	1.17
47	0.73	2.37	0.83	2.70			0.78	2.54
48	0.45	1.46	0.41	1.33	0.33	1.07	0.35	1.14
49	0.32	1.04	0.29	0.94	0.30	0.98	0.41	1.33
50	0.06	0.20	0.07	0.23	0.07	0.23	0.06	0.20

**Appendix 3 Continued – Raw Data Aug 2003 – Nov 2004 & Averages**

TUBE ID	Aug-04		Sep-04		Oct-04		Nov-04		Average	
	ppb	Ug/m3	ppb	ug/m3	ppb	ug/m3	ppb	ug/m3	ppb	ug/m3
1	0.23	0.75	0.14	0.46	0.37	1.20	0.37	1.20	0.44	1.43
2	0.32	1.04	0.68	2.21	0.22	0.72	0.34	1.11	0.42	1.36
3	0.58	1.89	0.13	0.42	0.48	1.56	0.50	1.63	0.82	2.66
4	0.85	2.76	0.22	0.72	0.37	1.20	0.53	1.72	1.10	3.57
5	0.44	1.43	0.12	0.39	0.36	1.17	0.30	0.98	0.45	1.46
6	0.32	1.04	0.13	0.42	0.27	0.88	0.31	1.01	0.36	1.18
7	0.47	1.53	0.28	0.91	0.25	0.81	0.29	0.94	0.36	1.17
8			0.18	0.59	0.21	0.68	0.37	1.20	0.34	1.11
9	0.36	1.17	0.13	0.42	0.07	0.23	0.28	0.91	0.25	0.81
10	0.33	1.07	0.56	1.82	0.30	0.98	0.35	1.14	0.38	1.22
11	0.43	1.40	0.06	0.20	0.35	1.14	0.28	0.91	0.35	1.14
12	0.45	1.46	0.06	0.20	0.27	0.88	0.27	0.88	0.33	1.06
13	0.61	1.98	0.06	0.20	0.62	2.02	0.46	1.50	0.56	1.82
14	1.56	5.07	0.44	1.43	0.90	2.93	0.38	1.24	0.83	2.69
15	0.78	2.54	0.36	1.17	0.55	1.79	0.25	0.81	0.44	1.44
16	0.35	1.14	0.18	0.59	0.29	0.94	0.28	0.91	0.45	1.46
17	0.54	1.76	0.10	0.33	0.29	0.94	0.26	0.85	0.33	1.07
18	3.14	10.21	1.00	3.25	1.65	5.36	1.06	3.45	1.21	3.95
19	0.66	2.15	0.07	0.23	0.60	1.95	0.56	1.82	0.60	1.93
20			0.38	1.24	0.47	1.53	0.87	2.83	0.93	3.02
21	1.80	5.85	0.13	0.42	0.80	2.60	0.53	1.72	1.40	4.55
22	2.09	6.79	0.26	0.85	0.87	2.83	2.17	7.05	1.73	5.62
23			0.19	0.62	0.80	2.60	1.49	4.84	1.59	5.18
24					0.15	0.49	0.24	0.78	0.33	1.06
25	0.17	0.55	0.24	0.78	0.14	0.46	0.34	1.11	0.31	1.02
26	0.85	2.76	0.23	0.75	0.82	2.67	0.51	1.66	0.58	1.88
27	0.77	2.50	0.06	0.20	1.02	3.32	0.36	1.17	0.58	1.89
28	0.83	2.70	0.50	1.63	1.04	3.38	0.44	1.43	0.62	2.02
29	0.50	1.63	0.19	0.62	0.53	1.72	0.39	1.27	0.45	1.47
30	0.48	1.56	0.06	0.20	0.69	2.24	0.28	0.91	0.47	1.54
31	0.48	1.56	0.45	1.46	0.61	1.98	0.38	1.24	0.47	1.53
32	0.51	1.66	0.79	2.57	0.50	1.63	0.44	1.43	0.59	1.93
33	0.43	1.40	0.29	0.94	0.50	1.63	0.45	1.46	0.58	1.89
34	0.34	1.11	0.30	0.98	0.29	0.94	0.33	1.07	0.48	1.57
35	0.36	1.17	0.24	0.78	0.26	0.85	0.25	0.81	0.36	1.16
36	0.34	1.11	0.35	1.14	0.30	0.98	0.27	0.88	0.43	1.39
37					0.33	1.07	0.42	1.37	0.46	1.50
38	0.33	1.07	0.06	0.20	0.17	0.55	0.33	1.07	0.30	0.98
39	0.36	1.17	0.37	1.20	0.41	1.33	0.63	2.05	0.71	2.31
40	0.58	1.89	0.16	0.52	0.53	1.72	0.30	0.98	0.40	1.31
41	0.66	2.15	0.16	0.52	0.63	2.05	0.57	1.85	0.59	1.91
42	0.49	1.59	0.50	1.63	0.82	2.67	0.68	2.21	0.80	2.61

43	0.35	1.14	1.15	3.74	0.70	2.28	1.10	3.58	0.92	2.98
44	0.36	1.17	0.06	0.20	0.66	2.15	1.40	4.55	0.89	2.90
45	0.44	1.43	0.96	3.12	0.61	1.98	1.27	4.13	0.95	3.09
46	0.30	0.98	1.38	4.49	0.41	1.33			0.64	2.09
47	1.02	3.32	0.45	1.46	1.10	3.58	0.57	1.85	0.84	2.74
48	0.57	1.85	0.06	0.20	0.58	1.89	0.38	1.24	0.47	1.53
49	0.52	1.69			0.53	1.72	0.32	1.04	0.48	1.55
50	0.07	0.23	0.06	0.20	0.07	0.23			0.07	0.22

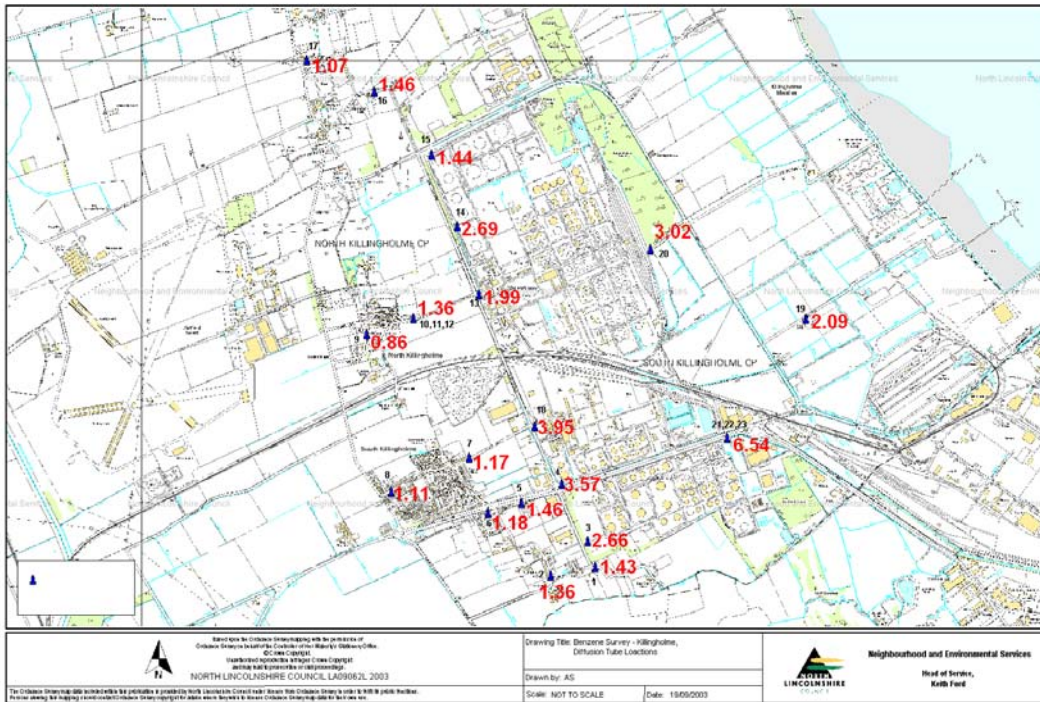
**Appendix 4 - Monthly Data Not Used**

ID	Data available	Data used	
9	100	92	Nov. data not used, concentration = control
10			Maximum value of three tubes was used for each month.
11			
12			
13	92	83	Oct. Data not used, concentration = control
19	100	92	Oct. Data not used, concentration = control
21			Maximum value of three tubes was used for each month.
22			
23			
35	92	75	Jul. Aug. data not used, concentration = control value
38	75	67	Oct. data not used, concentration = control value
48	100	92	Oct. data not used, concentration = control value

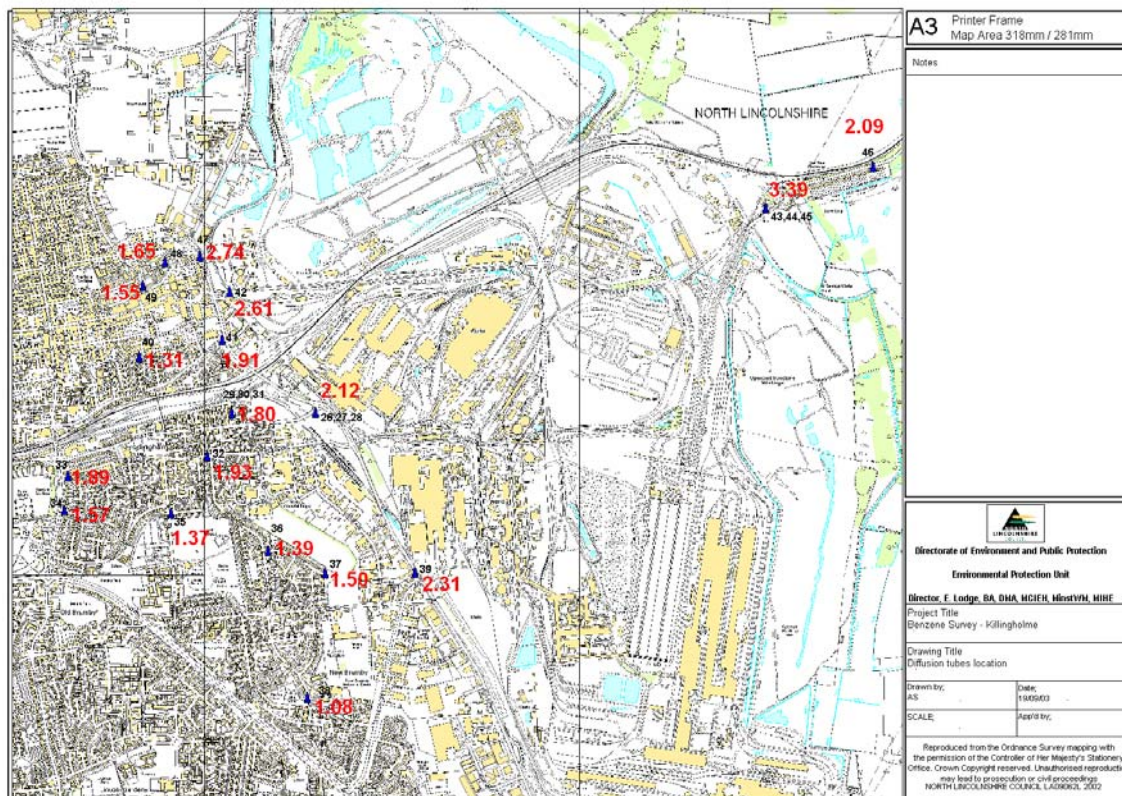


## Appendix 5. Monitoring locations and Concentrations

Killingholme diffusion tube locations and corresponding concentrations.



## Killingholme diffusion tube locations and corresponding concentrations.



## **Appendix 6. Guidance for determining relevant receptors**

The Air Quality Regulations 2002 and Technical Guidance LAQM. TG(03) state that likely exceedences of the objectives should be assessed in relation to 'the quality of the air at locations which are situated outside of buildings or other natural or man-made structures, above or below ground, and where members of the public are regularly present'. Air quality assessments should therefore be focused on those locations where members of the public are likely to be regularly present and are likely to be exposed over the averaging period of the objective. exceedences of the objectives are not considered at locations where relevant public exposure would not be realistic. It is reasonable to consider land designated for some form of public use, including residential development, but not currently in such use, as being a location with relevant exposure.

Several factors have been taken into account when developing the guidance on locations considered relevant. The long-term objectives apply where members of the public are likely to be exposed over the averaging period of the objective. This does not require the same individual to be present for a full year at a particular location, but the location must be one where people are likely to be regularly present for long periods. For instance, in the case of the annual mean objectives this might be where people are exposed for a cumulative period of 6 months in a year.

Further guidance on areas where air quality objectives apply is shown in Box 1.4 overleaf, an extract from Technical Guidance LAQM. TG(03).

Box 1.4: Examples of where the Air Quality Objectives should/should not apply		
Averaging Period	Objectives should apply at:	Objectives should generally not apply at:
Annual mean	<p>All locations where members of the public might be regularly exposed.</p> <p>Building facades of residential properties, schools, hospitals, libraries etc.</p>	<p>Building facades of offices or other places of work where members of the public do not have regular access.</p> <p>Gardens of residential properties.</p> <p>Kerbside sites (as opposed to locations at the building facade), or any other location where public exposure is expected to be short term.</p>
24-hour mean and 8-hour mean	<p>All locations where the annual mean objective would apply.</p> <p>Gardens of residential properties<sup>9</sup>.</p>	<p>Kerbside sites (as opposed to locations at the building facade), or any other location where public exposure is expected to be short term.</p>
1-hour mean	<p>All locations where the annual mean and 24 and 8-hour mean objectives apply.</p> <p>Kerbside sites (e.g. pavements of busy shopping streets)</p> <p>Those parts of car parks, bus stations and railway stations etc. which are not fully enclosed, where the public might reasonably be expected to spend 1-hour or more.</p> <p>Any outdoor locations to which the public might reasonably be expected to spend 1-hour or longer.</p>	<p>Kerbside sites where the public would not be expected to have regular access.</p>
15-min mean	<p>All locations where members of the public might reasonably be exposed for a period of 15 minutes or longer</p>	

Source; Local Air Quality Management. Technical Guidance LAQM. TG(03), Defra, 2003.