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Part 2: Automatic Analysers

Site Name	OS Grid Reference	Start Date	Finish Date	Pollutants measured	Type of machine	Site Type	Data Ratified. *
Allanby Street	SE 8927311446	1st July 2005	-	PM ₁₀	R&P TEOM	Urban Industrial	Between April 2006 and end June 2007.
Appleby Village	SE 9507914767	8th February 2007	-	PM ₁₀	R&P TEOM	Urban Background	To end June 2007.
Broughton	SE 9604809411	10th March 2006	-	PM ₁₀	R&P TEOM	Urban Background	Between April 2006 and end June 2007.
East Common Lane	SE 9066209791	3rd March 2005	-	PM ₁₀	R&P TEOM	Urban Industrial	Between April 2006 and end June 2007.
Gallagher Retail Park	SE 8671411110	24th January 2006	-	NO ₂	Airpointer	Roadside	To end of June 2007.
High Santon	SE 9327112089	5th January 2007	-	PM ₁₀	Partisol 2025	Urban Industrial	To end of December 2007.
Killingholme	TA 1488016120	6th March 2003	-	NO ₂ , PM ₁₀ , SO ₂	R&P TEOM	Urban Industrial	To end June 2007.
Kingsway House	SE 8914309886	22nd August 2005	-	NO ₂	Airpointer	Roadside	Between April 2006 and end June 2007.
Lakeside	SE 9175508242	23rd February 2005	10th August 2006	PM ₁₀	Partisol 2025	Urban Industrial	All data.
Lincoln Gardens	SE 8946508938	1st December 2004	-	PM ₁₀	R&P TEOM	Urban Background	Between April 2006 and end June 2007.
Low Santon	SE 9294711937	1st October 2005	-	NO ₂ , PAHs, PM ₁₀ , SO ₂	Digital (PAHs), TEOM (PM ₁₀), Ambirak (NO ₂ and SO ₂).	Urban Industrial	To end of June 2007.
Scunthorpe	SE 9055910681	15th December 2007	18th March 2004	PAHs, PM ₁₀ , SO ₂	Andersen (PAH), TEOM, ET 100A (SO ₂)	Urban Industrial	All data.
Scunthorpe Town	SE 9031510830	6th June 2004 (Digital PAH, December 2006)	-	NO ₂ , PAHs, PM ₁₀ , SO ₂	Monitor Labs 9841B (NO ₂), Anderson and Digital (PAH), TEOM and Partisol (PM ₁₀), ET 100A (SO ₂).	Urban Industrial	PM ₁₀ , SO ₂ to end of September 2007. NO ₂ to end of June 2007.

Table A1: Details of the air quality monitoring sites operated by North Lincolnshire Council.

Notes: If data prior to April 2006 has not been ratified, then it will remain provisional as the sites were not members of the calibration club. If data after April 2006 has not been ratified then it will be ratified in due course.

Appleby Village and Broughton are classified as urban background, although not in Scunthorpe itself, they are considered to provide a suitable background measure for the area.

Killingholme is not strictly an urban industrial site, given its location in a village. However, it is neither suitable for suburban or rural

Part 3: QA/QC

In order to minimise measurement uncertainty it is important to apply stringent quality assurance and quality control (QA/QC) procedures to monitoring programmes. North Lincolnshire Council therefore subscribe to a service known as the 'Calibration Club' operated by AEA Energy and Environment.

AEA Energy and Environment carry out data management services on behalf of the Council using the same procedures as those applied to the UK Government's national network monitoring stations (i.e. The AURN). This service incorporates:

- Daily data collection,
- Screening and provisional scaling of data,
- Full ratification of data sets,
- Independent equipment audits at six-monthly intervals,
- An audit report detailing any required data management actions.

The TEOMs receive fortnightly site visits by Council staff, which on an alternating basis entail:

- i.) F1 pressed only; as a result the machine performs internal calibrations.
- ii.) F1 pressed, a filter change, this is done earlier if the load on the filter reaches 80%, and cleaning of TEOM head.

The Airpointers now receive fortnightly calibrations, which on an alternating basis entail:

- i.) Zero only calibration done remotely.
- ii.) Zero and span calibrations, filter change.

The NO_x and SO₂ analysers at Low Santon, Killingholme and Scunthorpe Town received fortnightly zero and span calibrations and filter change.

The contract for the supply and weighing of Partisol filters is currently let to AEA Energy and Environment. Cassettes of fourteen Emfab filters are

exchanged on a fortnightly basis, AEA dial into the Partisol on a daily basis to download appropriate data and check its operation.

The filters are conditioned in-line with BS EN 12341:1999 and weighing procedures utilise UKAS calibrated precision balances. AEA are also independently certified to ISO 9001 and ISO14001 for their quality and environmental management systems. With regards to balance drift the data being produced in line with NPL recommendations. Results are typically received three weeks after the cassette has been received by AEA, thus upto five weeks after exposure.

Signal Ambitech are contracted on a 48-hour emergency callout basis to deal with any faults with the Killingholme, Low Santon or Scunthorpe Town analysers, they also conduct six monthly services. Airmonitors are contracted to do the same for the Partisols, TEOMs and Airpointers, except the callout is on a five-day basis.

The PAH monitors are visited by Environmental Protection Team staff on a fortnightly basis, following the instructions as set out by AEA. The heavy metals Partisols will be visited on a weekly basis, with head cleaning done on a four weekly basis, following the instructions as set out by NPL. Initial site visits for breakdowns at any of these sites are also done.

Part 4: Nitrogen Dioxide

The diffusion tubes are analysed by South Yorkshire Laboratories, the method used is 50% TEA with 50% acetone.

The Review and Assessment Helpdesk has issued a FAQ relating to diffusion tube precision. In this document, the laboratories used for NO₂ diffusion tubes were given graded for their precision, either good or poor, based on several studies. Precision is how well a particular concentration can be reproduced. In the case of diffusion tubes the known standard is taken to be an automatic monitoring station.

Rotherham MBC / South Yorks Lab have achieved good precision for all but one of the six samples in 2006. In 2007 two of the six samples were considered to be good precision and two of poor precision. This performance is reasonable compared to the other laboratories available.

Rotherham MBC / South Yorks	
2006	G
2006	G
2006	G
2006	G
2006	G
2006	P
2007	G
2007	P
2007	P
2007	G
2007	G
2007	G

Figure A2: The precision of SY Labs NO₂ diffusion tubes. ¹⁹

Bias correction takes account of the accuracy of tubes: they are cheap and easy to deploy, but are not as accurate as automatic machines. In addition, results can vary upon several factors including tube preparation, laboratory used, analysis method and type of substrate. Accuracy is how well a tube

performs compared to a known standard, in this case an automatic monitor is taken to be the known, accurate standard.

A provisional bias correction factor has been calculated for Scunthorpe Town, Gallagher Retail Park and Kingsway House, see Figures A5 to A7. In the 2007 Detailed Assessment the bias correction factor used for 2006 data was based on provisional data from the automatic monitoring station, this has been re-calculated with a fully ratified data set and is shown in Figure A4. A re-calculation of the 2005 bias correction factor has also been done, see Figure A3.

The national bias correction factor has been downloaded using the latest available (March 2008) diffusion tube survey.²⁰

Checking Precision and Accuracy of Triplicate Tubes

Diffusion Tubes Measurements									
Period	Start Date dd/mm/yyyy	End Date dd/mm/yyyy	Tube 1 $\mu\text{g m}^{-3}$	Tube 2 $\mu\text{g m}^{-3}$	Tube 3 $\mu\text{g m}^{-3}$	Triplicate Mean	Standard Deviation	Coefficient of Variation (CV)	95% CI of mean
1	04/01/2005	01/02/2005	38	45	40	41	3.6	9	9.0
2	01/02/2005	01/03/2005	44	41	41	42	1.7	4	4.3
3	01/03/2005	31/03/2005	38	35	38	37	1.7	5	4.3
4	31/03/2005	03/05/2005							
5	03/05/2005	01/06/2005	20	16	30	22	7.2	33	17.9
6	01/06/2005	28/06/2005	20		24	22	2.8	13	25.4
7	28/06/2005	02/08/2005	21	21	18	20	1.7	9	4.3
8	02/08/2005	30/08/2005	20	22	19	20	1.5	8	3.8
9	30/08/2005	01/10/2005	32		29	31	2.1	7	19.1
10	01/10/2005	01/11/2005	34	35	27	32	4.4	14	10.8
11	01/11/2005	30/11/2005	40	40	40	40	0.0	0	0.0
12	30/11/2005	02/01/2006		37	43	40	4.2	11	38.1
13									

It is necessary to have results for at least two tubes in order to calculate the precision of the measurements

Automatic Method		Data Quality Check	
Period Mean	Data Capture (% DC)	Tubes Precision Check	Automatic Monitor Data
25.17134	94.49404762	Good	Good
27.39772	91.51785714	Good	Good
21.29411	94.30555556	Good	Good
20.07338	95.32828283		Good
16	95.83333333	Poor Precision	Good
18	95.21604938	Good	Good
16	92.61904762	Good	Good
14	95.23809524	Good	Good
18	51.04166667	Good	or Data Capture
	0	Good	or Data Capture
33.52552	90.0862069	Good	Good
30.20586	88.38383838	Good	Good

Overall survey --> Good precision Poor Overall DC

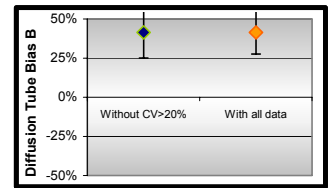
(Check average CV & DC from Accuracy calculations)

Site Name/ ID: Scunthorpe Town

Precision 10 out of 11 periods have a CV smaller than 20%

Accuracy (with 95% confidence interval)	
without periods with CV larger than 20%	
Bias calculated using 8 periods of data	
Bias factor A	0.71 (0.63 - 0.8)
Bias B	41% (25% - 58%)
Diffusion Tubes Mean:	33 $\mu\text{g m}^{-3}$
Mean CV (Precision):	7
Automatic Mean:	23 $\mu\text{g m}^{-3}$
Data Capture for periods used:	93%
Adjusted Tubes Mean:	23 (21 - 26) $\mu\text{g m}^{-3}$

Accuracy (with 95% confidence interval)	
WITH ALL DATA	
Bias calculated using 9 periods of data	
Bias factor A	0.71 (0.65 - 0.78)
Bias B	41% (27% - 55%)
Diffusion Tubes Mean:	32 $\mu\text{g m}^{-3}$
Mean CV (Precision):	10 caution
Automatic Mean:	22 $\mu\text{g m}^{-3}$
Data Capture for periods used:	93%
Adjusted Tubes Mean:	22 (21 - 25) $\mu\text{g m}^{-3}$



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Figure A3: The bias sheet for the co-location study at Scunthorpe Town in 2005.

Checking Precision and Accuracy of Triplicate Tubes

Diffusion Tubes Measurements									
Period	Start Date dd/mm/yyyy	End Date dd/mm/yyyy	Tube 1 $\mu\text{g m}^{-3}$	Tube 2 $\mu\text{g m}^{-3}$	Tube 3 $\mu\text{g m}^{-3}$	Triplicate Mean	Standard Deviation	Coefficient of Variation (CV)	95% CI of mean
1	03/01/2006	31/01/2006	27	34	33	31	3.8	12	9.4
2	31/01/2006	28/02/2006		33	35	34	1.4	4	12.7
3	28/02/2006	04/04/2006		25					
4	04/04/2006	02/05/2006	27	23	20	23	3.5	15	8.7
5	02/05/2006	30/05/2006	23	24	19	22	2.6	12	6.6
6	30/05/2006	28/06/2006	20		16	18	2.8	16	25.4
7	28/06/2006	01/08/2006							
8	01/08/2006	30/08/2006	23	25	23	24	1.2	5	2.9
9	30/08/2006	03/10/2006	28	28	26	27	1.2	4	2.9
10	03/10/2006	31/10/2006	34	34	35	34	0.6	2	1.4
11	31/10/2006	28/11/2006	36	27	37	33	5.5	17	13.7
12	28/11/2006	03/01/2007	32	32	33	32	0.6	2	1.4
13									

Automatic Method		Data Quality Check	
Period Mean	Data Capture (% DC)	Tubes Precision Check	Automatic Monitor Data
26.38325	90.625	Good	Good
27.15546	99.55357143	Good	Good
21.11789	99.16666667		Good
17.77552	92.41071429	Good	Good
18	98.80952381	Good	Good
15	97.4137931	Good	Good
15	99.26470588		Good
14	96.12068966	Good	Good
15	68.50490196	Good	
19	90.92261905	Good	Good
22.45567	99.70238095	Good	Good
22.71581	98.84259259	Good	Good

Overall survey --> Good precision Good Overall DC

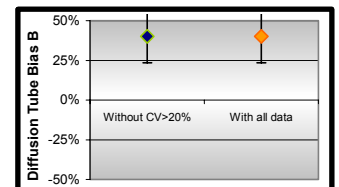
(Check average CV & DC from Accuracy calculations)

Site Name/ ID: Scunthorpe Town

Precision 10 out of 10 periods have a CV smaller than 20%

Accuracy (with 95% confidence interval)	
without periods with CV larger than 20%	
Bias calculated using 9 periods of data	
Bias factor A	0.72 (0.64 - 0.82)
Bias B	39% (22% - 55%)
Diffusion Tubes Mean:	28 $\mu\text{g m}^{-3}$
Mean CV (Precision):	9
Automatic Mean:	20 $\mu\text{g m}^{-3}$
Data Capture for periods used:	96%
Adjusted Tubes Mean:	20 (18 - 23) $\mu\text{g m}^{-3}$

Accuracy (with 95% confidence interval)	
WITH ALL DATA	
Bias calculated using 9 periods of data	
Bias factor A	0.72 (0.64 - 0.82)
Bias B	39% (22% - 55%)
Diffusion Tubes Mean:	28 $\mu\text{g m}^{-3}$
Mean CV (Precision):	9
Automatic Mean:	20 $\mu\text{g m}^{-3}$
Data Capture for periods used:	96%
Adjusted Tubes Mean:	20 (18 - 23) $\mu\text{g m}^{-3}$



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Figure A4: The bias sheet for the co-location study at Scunthorpe Town, using 2006 ratified data.

Checking Precision and Accuracy of Triplicate Tubes

Diffusion Tubes Measurements									
Period	Start Date dd/mm/yyyy	End Date dd/mm/yyyy	Tube 1 $\mu\text{g m}^{-3}$	Tube 2 $\mu\text{g m}^{-3}$	Tube 3 $\mu\text{g m}^{-3}$	Triplicate Mean	Standard Deviation	Coefficient of Variation (CV)	95% CI of mean
1	03/01/2007	30/01/2007	31	34	30	32	2.1	7	5.2
2	30/01/2007	28/02/2007	36	36	38	37	1.2	3	2.9
3	28/02/2007	04/04/2007	23	31	32	29	4.9	17	12.3
4	04/04/2007	02/05/2007	25	26	23	25	1.5	6	3.8
5	02/05/2007	30/05/2007	17	20	15	17	2.5	15	6.3
6	30/05/2007	04/07/2007	20	21	17	19	2.1	11	5.2
7	04/07/2007	31/07/2007	22	22	19	21	1.7	8	4.3
8	31/07/2007	29/08/2007	17	18	20	18	1.5	8	3.8
9	29/08/2007	03/10/2007	26	25	20	24	3.2	14	8.0
10	03/10/2007	31/10/2007	34	32	30	32	2.0	6	5.0
11	31/10/2007	29/11/2007	38	38	34	37	2.3	6	5.7
12	29/11/2007	03/01/2008	38	36	37	37	1.0	3	2.5
13									

Automatic Method		Data Quality Check	
Period Mean	Data Capture (% DC)	Tubes Precision Check	Automatic Monitor Data
20.5547	96.75925926	Good	Good
24.85753	95.40229885	Good	Good
18.81098	99.76190476	Good	Good
14.93214	99.55357143	Good	Good
11	87.05357143	Good	Good
12	97.97619048	Good	Good
12	99.07407407	Good	Good
12	95.54597701	Good	Good
14	100	Good	Good
22	93.45238095	Good	Good
24.53377	99.56896552	Good	Good
27.55066	81.54761905	Good	Good

It is necessary to have results for at least two tubes in order to calculate the precision of the measurements

Overall survey --> **Good precision** **Good Overall DC**

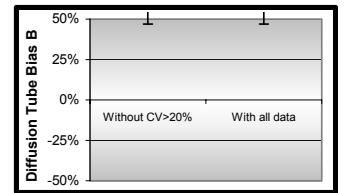
(Check average CV & DC from Accuracy calculations)

Site Name/ ID: **Scunthorpe Town**

Precision **12 out of 12 periods have a CV smaller than 20%**

Accuracy (with 95% confidence interval)	
without periods with CV larger than 20%	
Bias calculated using 12 periods of data	
Bias factor A	0.66 (0.62 - 0.69)
Bias B	53% (44% - 61%)
Diffusion Tubes Mean:	27 $\mu\text{g m}^{-3}$
Mean CV (Precision):	9
Automatic Mean:	18 $\mu\text{g m}^{-3}$
Data Capture for periods used:	95%
Adjusted Tubes Mean:	18 (17 - 19) $\mu\text{g m}^{-3}$

Accuracy (with 95% confidence interval)	
WITH ALL DATA	
Bias calculated using 12 periods of data	
Bias factor A	0.66 (0.62 - 0.69)
Bias B	53% (44% - 61%)
Diffusion Tubes Mean:	27 $\mu\text{g m}^{-3}$
Mean CV (Precision):	9
Automatic Mean:	18 $\mu\text{g m}^{-3}$
Data Capture for periods used:	95%
Adjusted Tubes Mean:	18 (17 - 19) $\mu\text{g m}^{-3}$



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Figure A5: The bias sheet for the co-location study at Scunthorpe Town, 2007.

Checking Precision and Accuracy of Triplicate Tubes

Diffusion Tubes Measurements									
Period	Start Date dd/mm/yyyy	End Date dd/mm/yyyy	Tube 1 $\mu\text{g m}^{-3}$	Tube 2 $\mu\text{g m}^{-3}$	Tube 3 $\mu\text{g m}^{-3}$	Triplicate Mean	Standard Deviation	Coefficient of Variation (CV)	95% CI of mean
1	03/01/2007	30/01/2007	56	32	24	37	16.7		41.4
2	30/01/2007	28/02/2007	42	39	34	38	4.0	11	10.0
3	28/02/2007	04/04/2007	43	41	34	39	4.7	12	11.7
4	04/04/2007	02/05/2007	47	31	35	38	8.3		20.7
5	02/05/2007	30/05/2007	26	30	20	25	5.0		12.5
6	30/05/2007	04/07/2007	30	32	29	30	1.5	5	3.8
7	04/07/2007	31/07/2007	28	25	25	26	1.7	7	4.3
8	31/07/2007	29/08/2007	29	26	25	27	2.1	8	5.2
9	29/08/2007	03/10/2007	28	34	28	30	3.5	12	8.6
10	03/10/2007	31/10/2007	55	43	42	47	7.2	16	18.0
11	31/10/2007	29/11/2007	38	40	33	37	3.6	10	9.0
12	29/11/2007	03/01/2008	46	45	40	44	3.2	7	8.0
13									

Automatic Method		Data Quality Check	
Period Mean	Data Capture (% DC)	Tubes Precision Check	Automatic Monitor Data
21.76667	100		Good
34.39598	100	Good	Good
23.15679	100	Good	Good
21.34747	100		Good
17	99.10714286		Good
27	99.28571429	Good	Good
22	99.84567901	Good	Good
34	100	Good	Good
39	100	Good	Good
37	98.80952381	Good	Good
46.67309	99.85632184	Good	Good
54.18304	96.19047619	Good	Good

Overall survey --> **Good Overall DC**

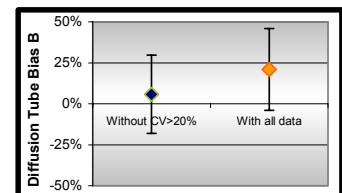
(Check average CV & DC from Accuracy calculations)

Site Name/ ID: **Kingsway**

Precision **9 out of 12 periods have a CV smaller than 20%**

Accuracy (with 95% confidence interval)	
without periods with CV larger than 20%	
Bias calculated using 9 periods of data	
Bias factor A	1 (0.81 - 1.31)
Bias B	0% (-24% - 24%)
Diffusion Tubes Mean:	35 $\mu\text{g m}^{-3}$
Mean CV (Precision):	10
Automatic Mean:	35 $\mu\text{g m}^{-3}$
Data Capture for periods used:	99%
Adjusted Tubes Mean:	35 (29 - 46) $\mu\text{g m}^{-3}$

Accuracy (with 95% confidence interval)	
WITH ALL DATA	
Bias calculated using 12 periods of data	
Bias factor A	0.9 (0.74 - 1.16)
Bias B	11% (-14% - 36%)
Diffusion Tubes Mean:	35 $\mu\text{g m}^{-3}$
Mean CV (Precision):	
Automatic Mean:	31 $\mu\text{g m}^{-3}$
Data Capture for periods used:	99%
Adjusted Tubes Mean:	31 (26 - 40) $\mu\text{g m}^{-3}$



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Figure A6: The bias sheet for the co-location study at Kingsway House for 2007.

Checking Precision and Accuracy of Triplicate Tubes

Diffusion Tubes Measurements									
Period	Start Date dd/mm/yyyy	End Date dd/mm/yyyy	Tube 1 μgm^{-3}	Tube 2 μgm^{-3}	Tube 3 μgm^{-3}	Triplicate Mean	Standard Deviation	Coefficient of Variation (CV)	95% CI of mean
1	03/01/2007	30/01/2007	35	36	40	37	2.6	7	6.6
2	30/01/2007	28/02/2007	27	40	42	36	8.1	22	20.2
3	28/02/2007	04/04/2007	28	33	33	31	2.9	9	7.2
4	04/04/2007	02/05/2007	29	25	28	27	2.1	8	5.2
5	02/05/2007	30/05/2007		11					
6	30/05/2007	04/07/2007	23	24	23	23	0.6	2	1.4
7	04/07/2007	31/07/2007							
8	31/07/2007	29/08/2007							
9	29/08/2007	03/10/2007	27	24	24	25	1.7	7	4.3
10	03/10/2007	31/10/2007	35	34	34	34	0.6	2	1.4
11	31/10/2007	29/11/2007	37	37	35	36	1.2	3	2.9
12	29/11/2007	03/01/2008	37	32	36	35	2.6	8	6.6
13									

It is necessary to have results for at least two tubes in order to calculate the precision of the measurements

Automatic Method		Data Quality Check	
Period Mean	Data Capture (% DC)	Tubes Precision Check	Automatic Monitor Data
21.54059	100	Good	Good
27.81991	97.4137931	Poor Precision	Good
21.13405	100	Good	Good
16.99656	99.4047619	Good	Good
22	99.4047619		Good
21	99.64285714	Good	Good
24	100		Good
23	99.85632184		Good
26	100	Good	Good
31	99.4047619	Good	Good
34.26547	99.85632184	Good	Good
27.68071	73.45238095	Good	for Data Capture

Overall survey -->

Good precision Good Overall DC

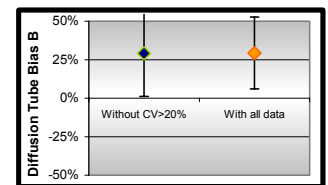
(Check average CV & DC from Accuracy calculations)

Site Name/ ID: Gallagher Retail Park

Precision 8 out of 9 periods have a CV smaller than 20%

Accuracy (with 95% confidence interval)	
without periods with CV larger than 20%	
Bias calculated using 7 periods of data	
Bias factor A	0.8 (0.66 - 1.03)
Bias B	25% (-3% - 53%)
Diffusion Tubes Mean:	31 μgm^{-3}
Mean CV (Precision):	5
Automatic Mean:	25 μgm^{-3}
Data Capture for periods used:	100%
Adjusted Tubes Mean:	25 (20 - 32) μgm^{-3}

Accuracy (with 95% confidence interval)	
WITH ALL DATA	
Bias calculated using 8 periods of data	
Bias factor A	0.8 (0.67 - 0.98)
Bias B	25% (2% - 49%)
Diffusion Tubes Mean:	31 μgm^{-3}
Mean CV (Precision):	8
Automatic Mean:	25 μgm^{-3}
Data Capture for periods used:	99%
Adjusted Tubes Mean:	25 (21 - 31) μgm^{-3}



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Figure A7: The bias sheet for the co-location study at Gallagher Retail Park 2007.