



# Investigation of the possible effect of the use of Scottish Specific Air Quality Maps in the LAQM process in four selected Local Authorities

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<b>Title</b>	Investigation of the possible effect of the use of Scottish Specific Air Quality Maps in the LAQM process in four selected Local Authorities
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## Executive summary

As part of the Scottish Air Quality Database contract, AEA has undertaken additional investigation of air quality mapping throughout Scotland. In 2009, this work focussed on using the additional PM<sub>10</sub> and PM<sub>2.5</sub> data from the Scottish Partisol monitoring programme to produce Scotland specific maps for these pollutants.

These Scotland specific maps showed generally good agreement with the corresponding UK maps. However, there were some differences and AEA were requested to liaise with four Scottish Local Authorities to investigate the possible effect of these differences on the Local Air Quality Management (LAQM) process in Scotland. The four Local Authorities were two with long term exceedences and declared Air Quality Management Areas (AQMA) for PM<sub>10</sub> (Glasgow and N. Lanarkshire) and two with borderline concentrations compared to the Scottish Air Quality Objectives for PM<sub>10</sub> (Edinburgh and East Renfrewshire).

The study showed that:

- The main use of the background PM<sub>10</sub> maps by Local Authorities has been to roll forward 2008 measured concentrations to estimated 2010 concentrations for comparison with the Scottish Air Quality Objective
- To undertake this calculation, the source apportionment and forward projection factors are required for each square in addition to the mapped total PM<sub>10</sub> concentration. This breakdown of the total mapped PM<sub>10</sub> concentration has not been undertaken previously on a Scotland specific basis.
- However, use of the Scotland specific maps for forward projection in the 4 example authorities showed only very small differences compared to the use of the UK map data. These differences were generally smaller than rounding errors introduced when monitored concentrations are reduced to integer values.
- For comparison of the Scottish and UK mapping methodology alone, the 2007 Scottish maps have been compared UK with (PCM) maps for 2007. These correlations show very little difference between the two techniques (generally less than 1µgm<sup>-3</sup>, with the Scottish map generally showing lower results)
- However, the UK map data available to Local Authorities on [www.airquality.co.uk](http://www.airquality.co.uk) are based on 2006 maps projected forward to future years. These are the only data available to Local Authorities at present and hence, in assessing the overall difference to Authorities in using Scottish map data for their 2007 Updating and Screening assessment, the comparison between the UK map data available on [www.airquality.co.uk](http://www.airquality.co.uk) and the Scottish map data have also been plotted. This shows slightly larger differences than between the mapping methodology alone (see above). The difference is more in the range 1-2µgm<sup>-3</sup>, again with the Scottish maps giving lower results.

The results of this investigation provide useful information to inform the discussion on the requirements for pollution mapping in Scotland in future years.

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# 1 Background

As part of the Scottish Air Quality Database contract, additional investigation of mapping of air quality throughout Scotland on a 1\*1km grid square basis has been undertaken. Air pollution maps are already prepared for the whole of the UK within the Pollution Climate Mapping contract undertaken by AEA for The Scottish Government, DEFRA and the other Devolved Administrations.

The overall aim of the pollution mapping work within the Scottish database project is to produce improved, more accurate, pollution maps for Scotland. However, at the start of this project the database of reliable quality controlled air quality monitoring data for Scotland had yet to be built and hence, in the first year of the project the mapping work was restricted to using the additional data from the few sites already in the Scottish database to validate and calibrate the existing UK based maps for Scotland. This work demonstrated that the UK maps already gave a good representation of pollutant concentrations in Scotland.

The pollution mapping work in the second year of the contract focussed on using the additional PM<sub>10</sub> and PM<sub>2.5</sub> data from the Scottish Partisol monitoring programme<sup>1</sup> to produce Scotland specific maps for these pollutants. For these Scottish specific PM<sub>10</sub> and PM<sub>2.5</sub> maps, meteorological data for RAF Leuchars, close to Edinburgh, was used.

These Scottish specific maps showed generally good agreement with the corresponding UK maps. However, there were some differences and to investigate the possible effect of these differences on the Local Air Quality Management (LAQM) process in Scotland, AEA were asked to liaise with 4 Local Authorities to assess how they had used the maps in their LAQM process and, in particular in the preparation of the Updating and Screening Assessment (USA) that all Authorities were required to produce in 2009.

The four example Local Authorities were 2 with long term exceedences and declared Air Quality Management Areas (AQMA) for PM<sub>10</sub> (Glasgow and N. Lanarkshire) and two with borderline concentrations compared to the Scottish air Quality Objectives for PM<sub>10</sub> (Edinburgh and East Renfrewshire).

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<sup>1</sup> Measurement of PM<sub>10</sub> and PM<sub>2.5</sub> in Scotland with Gravimetric Samplers. AEAT/ENV/R/2702 Issue 1  
[http://www.scottishairquality.co.uk/documents/reports2/242090615\\_Scottish\\_Partisol\\_Report\\_Issue\\_1\\_12-06-09.pdf](http://www.scottishairquality.co.uk/documents/reports2/242090615_Scottish_Partisol_Report_Issue_1_12-06-09.pdf)

## 2 Use of Maps by Local Authorities

Initial discussions were undertaken with the relevant Authorities to identify how the UK background maps had been used in their LAQM assessment.

### 2.1 Glasgow

The Glasgow USA has been prepared and a copy of this was provided. Glasgow used the background map data to project forward measured PM<sub>10</sub> annual average concentrations from 2008 to 2010, following the methodology of LAQM TG(09) Box 2.2.

Glasgow were happy to revisit these calculations using the Scottish map data.

Suggested action:

Repeat forward projection calculations for monitoring data using Scottish specific maps.

### 2.2 North Lanarkshire

The N. Lanarkshire USA has been prepared but is not fully finalised and published yet. N Lanarkshire Council provided details of the monitoring sites for the repeat of the forward projection using the Scottish specific maps.

Suggested action:

Repeat forward projection calculations for monitoring data using Scottish specific maps.

### 2.3 Edinburgh

Edinburgh had not needed to use the PM<sub>10</sub> maps for modelling work within their current USA report. In the small number of cases where background concentrations were required, the measured PM<sub>10</sub> concentration from the St Leonards FDMS monitoring site was used. However, the maps and the source apportionment and forward projection data for the UK maps were used to predict 2010 concentrations for the PM<sub>10</sub> measurement sites in Edinburgh.

The current Detailed Assessment work being undertaken by Edinburgh is on a longer timeframe and will be primarily based on additional monitoring - plans are in hand for additional monitoring sites to be established. These will include a background site at Currie High School and a monitoring site on Queensferry Rd.

Suggested action:

Check PM<sub>10</sub> measurements at St Leonards compared to map concentrations for Scottish and UK background maps. Repeat forward projection calculations for monitoring data using Scottish specific maps.

### 2.4 East Renfrewshire

In East Renfrewshire, the USA, used the background maps to project forward PM<sub>10</sub> concentrations for the Sheddens Roundabout monitoring site from 2008 to 2010. Also, the background data for all 1\*1km squares in East Renfrewshire were presented and max, min and mean concentrations tabulated. However, because of the current debate over possible declaration of an AQMA at Sheddens, the Council are keen to be involved with additional assessment using the Scottish maps.

In the Detailed Assessment, background PM<sub>10</sub> concentrations from the Glasgow Walkmillglen reservoir monitoring site have been used as background data for the modelling. The modelling predicted very marginal exceedences of the PM<sub>10</sub> annual average in some areas in 2010.

**Suggested action:**

Check PM<sub>10</sub> measurements at Walkmillglen reservoir compared to map concentrations for Scottish and UK background maps. Repeat forward projection calculations for monitoring data using Scottish specific maps.

## **2.5 Conclusion of discussions with Local Authorities**

The key use of the background maps by the Local Authorities as part of the LAQM process has been in projecting forward 2008 measured concentrations to 2010 for comparison with the 2010 Air Quality Objective for PM<sub>10</sub>.

However, in their present form, the Scottish maps could not be used for this purpose as the source apportionment and forward projections had not been calculated. Hence, these needed to be determined before this assessment could be undertaken – this is discussed in Appendix 1.

In the two Local Authorities where background data have been used for other purposes, both have used locally monitored background data, rather than estimated concentrations from the maps. Hence, it will be useful to compare these measured background concentrations with both the UK and Scottish map concentrations for the relevant squares.

## 3 Results

### 3.1 Glasgow

#### Forward projection of measured concentrations

Based on the information obtained from the additional calculations on the Scotland Specific map data (Appendix 1), forward projection calculations of Local Authority roadside monitoring site data for 2008, to 2010, have been calculated and compared with those determined from the UK maps and with those provided in the Glasgow 2009 USA.

These data are summarised in Table 3.1.

**Table 3.1 Forward projection calculations for Glasgow.**

Site	Grid Ref. x	Grid Ref. y	2008 Monitoring data PM <sub>10</sub> µgm <sup>-3</sup>	Projected 2010 concentration (using Scottish maps) PM <sub>10</sub> µgm <sup>-3</sup>	Projected 2010 concentration (using UK maps)* PM <sub>10</sub> µgm <sup>-3</sup>	LA calculated projected 2010 Concentration PM <sub>10</sub> µgm <sup>-3</sup>	Difference between UK and Scottish methods PM <sub>10</sub> µgm <sup>-3</sup>
Glasgow Kerbside	258500	665500	23	21.4714632	21.72105514	22.0	0.249591946
Glasgow Byres Road	256500	666500	18	16.98564816	17.23319504	16.4	0.247546875
Glasgow Battlefield	258500	661500	15	14.35699213	14.54951207	14.7	0.19251994
Glasgow Abercromby	260500	664500	19	17.9317945	18.18180346	18.6	0.25008961
Glasgow Broomhill	255500	667500	19	17.88570024	18.1211718	18.0	0.235471559
Glasgow Nithsdale	257500	662500	21	19.39704782	19.67313729	20.4	0.276089474

\*As available from [www.airquality.co.uk](http://www.airquality.co.uk)

Note that 8 decimal places are provided simply to show the calculation – clearly this level of precision is not warranted in any final assessment of the results.

As can be seen in the table, the overall difference in using the Scotland or UK maps is very small, with a maximum difference of about 0.25µgm<sup>-3</sup>. At Glasgow Abercromby and Glasgow Broomhill, rounding to one decimal place would make the 2010 concentration 17.9µgm<sup>-3</sup> at both sites from the Scottish maps and 18.2µgm<sup>-3</sup> and 18.1µgm<sup>-3</sup> at Abercromby and Broomhill respectively from the UK maps. However, when rounded to integer values both results are the same.

The Local Authority commented that the small differences between the figures calculated in this work compared to those calculated by the Local Authority probably arises due to rounding errors. The Local Authority used the raw data for the annual means (to several decimal places) when calculating the projections whereas we have used the concentrations quoted in the USA which were rounded to integer values.

#### Overall comparison of Scottish and UK maps for Glasgow Area

Figure 3.1 shows a scatter plot of concentrations for all grid squares in the Glasgow area comparing the results of the Scottish and UK mapping for 2007. As can be seen, the correlation is very good, with the Scottish results lying slightly lower than the UK wide results.



**Figure 3.1 Correlation plot of Scottish vs UK PM<sub>10</sub> maps for Glasgow**

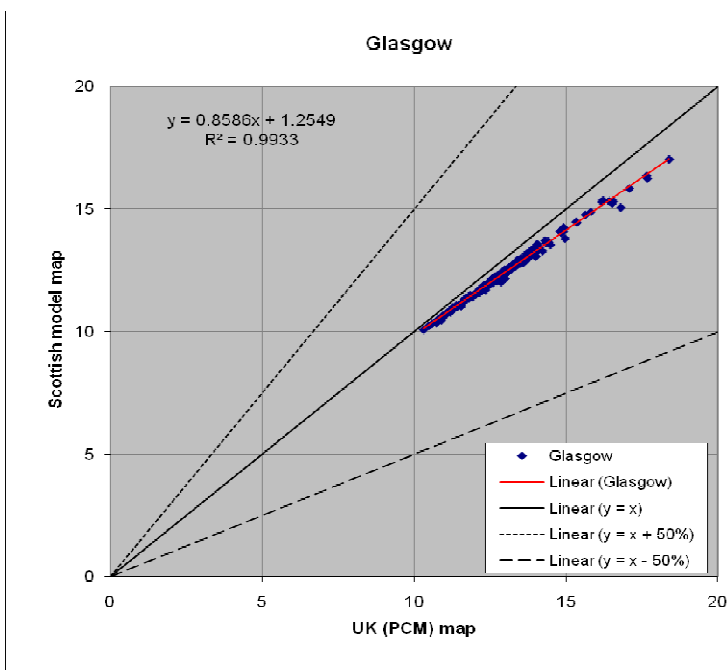
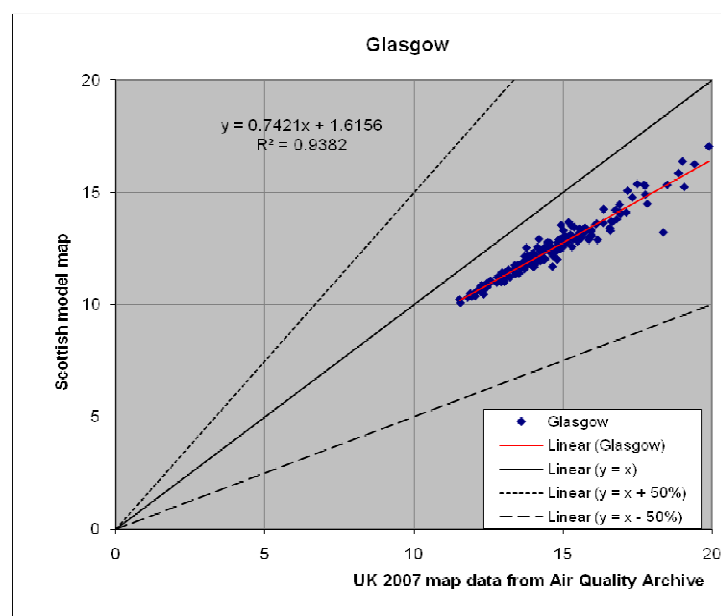


Figure 3.1 contains the latest available UK (PCM) map data based on 2007 UK wide mapping and hence reflects differences due to UK and Scottish mapping results only. However, due to the mismatch with the LAQM timetable, the UK map data available to Local Authorities on [www.airquality.co.uk](http://www.airquality.co.uk) are still data from 2006 map with a forward projection to 2007. Hence, whilst Figure 3.1 shows the difference due to UK and Scottish specific mapping alone, Figure 3.2 shows the difference between the UK maps available to Local Authorities on [www.airquality.co.uk](http://www.airquality.co.uk) and the corresponding Scottish maps for 2007.

**Figure 3.2 Correlation plot of Scottish vs UK map data from [www.airquality.co.uk](http://www.airquality.co.uk) for Glasgow**



Whilst the correlation is still very good, there is now a difference of about  $2-3\mu\text{g}\text{m}^{-3}$ , with the Scottish map giving lower results.

## 3.2 North Lanarkshire

### Forward projection of measured concentrations

Based on the information obtained from the additional calculations on the Scotland Specific map data, forward projection calculations of Local Authority roadside monitoring site data for 2008, to 2010, have been calculated and compared with those determined from the of the UK maps and with those provided by the Local authority.

These data are summarised in Table 3.2.

**Table 3.2. Forward projection calculations for N. Lanarkshire.**

Site	Grid Ref. x	Grid Ref. y	2008 Monitoring data PM <sub>10</sub> µgm <sup>-3</sup>	Projected 2010 concentration (using Scottish maps) PM <sub>10</sub> µgm <sup>-3</sup>	Projected 2010 concentration (using UK maps)* PM <sub>10</sub> µgm <sup>-3</sup>	LA calculated projected 2010 Concentration PM <sub>10</sub> µgm <sup>-3</sup>	Difference between UK and Scottish methods PM <sub>10</sub> µgm <sup>-3</sup>
Menteith Road	275458	656792	17.6	16.69823865	16.76620082	16.7	0.067962173
Croy	272775	675738	19	17.56198017	17.71808398	17.8	0.156103819
Calder Court	273667	663931	15	14.36235219	14.55333131	14.6	0.190979121
Harthill	288051	663975	16.5	15.3532962	15.44257747	15.5	0.089281275
Chapelhall	278174	663124	20.8	19.19385385	19.33042836	19.3	0.136574507
Moodiesburn	269929	670386	19.5	18.15593564	18.31603812	18.4	0.160102488

\*As available from [www.airquality.co.uk](http://www.airquality.co.uk)

In the case of N. Lanarkshire, the maximum difference between using the Scottish maps and the UK maps is less than 0.2µgm<sup>-3</sup>. In no cases does the difference lead to a change from exceedence to non-exceedence in 2010 at any site.

North Lanarkshire Council also point out the following:

It should be noted that the method of projecting PM<sub>10</sub> concentrations to 2010 is for roadside locations only, as the projections are in the main based on the expected decrease in concentrations due to improvements in vehicle emissions. The Croy and Harthill monitoring stations are influenced by road traffic emissions but are also strongly influenced by emissions from quarries, therefore the TG(09) method is not strictly applicable.

The definition of roadside is within 1-5m of the kerbside, extending to 15m in certain circumstances. The analyser location at Calder Court is further than 15m from the kerbside so the TG(09) projection method may not be strictly suitable for there either.

### Overall comparison of Scottish and UK maps for N. Lanarkshire Area

Figure 3.3 shows a scatter plot of concentrations for all grid squares in the N. Lanarkshire area comparing the results of the Scottish and UK mapping for 2007. As can be seen, the correlation is very good, with the Scottish results lying slightly lower than the UK wide results.

**Figure 3.3 Correlation plot of Scottish vs UK PM<sub>10</sub> maps for N. Lanarkshire**

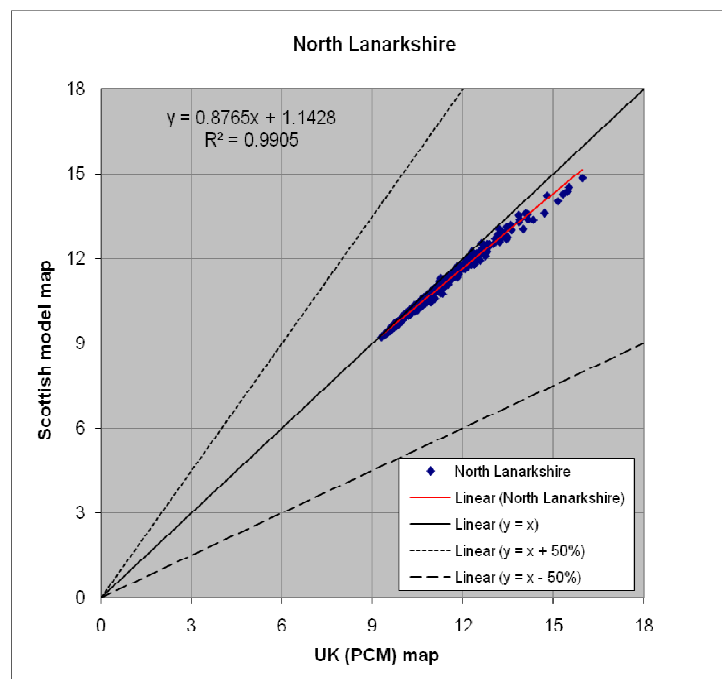
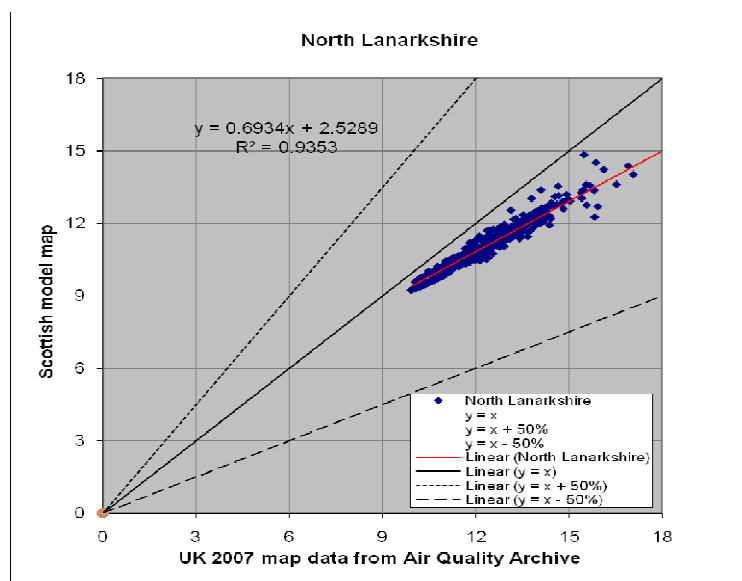


Figure 3.3 contains the latest available UK (PCM) map data based on 2007 UK wide mapping and hence reflects differences due to UK and Scottish mapping results only. However, due to the mismatch with the LAQM timetable, the UK map data available to Local Authorities on [www.airquality.co.uk](http://www.airquality.co.uk) are still data from 2006 map with a forward projection to 2007. Hence, whilst Figure 3.3 shows the difference due to UK and Scottish specific mapping alone, Figure 3.4 shows the difference between the UK maps available to Local Authorities on [www.airquality.co.uk](http://www.airquality.co.uk) and the corresponding Scottish maps for 2007.

**Figure 3.4 Correlation plot of Scottish vs UK map data from [www.airquality.co.uk](http://www.airquality.co.uk) for N. Lanarkshire**



Whilst the correlation is still very good, there is now a difference of about  $1-2\mu\text{g m}^{-3}$ , with the Scottish map giving lower results.

### 3.3 Edinburgh

#### Forward projection of measured concentrations

Based on the information obtained from the additional calculations on the Scotland Specific map data, forward projection calculations of Local Authority roadside monitoring site data for 2008, to 2010, have been calculated and compared with those determined from the of the UK maps and with those provided in the Draft Edinburgh 2009 USA.

These data are summarised in Table 3.3.

**Table 3.3. Forward projection calculations for Edinburgh.**

Site	Grid Ref. x	Grid Ref. y	2008 Monitoring data PM <sub>10</sub> µm <sup>-3</sup>	Projected 2010 concentration (using Scottish maps) PM <sub>10</sub> µgm <sup>-3</sup>	Projected 2010 concentration (using UK maps)* PM <sub>10</sub> µgm <sup>-3</sup>	LA calculated projected 2010 Concentration PM <sub>10</sub> µgm <sup>-3</sup>	Difference between UK and Scottish methods PM <sub>10</sub> µgm <sup>-3</sup>
Edinburgh Haymarket	323500	673500	19.5	18.33081194	18.47120338	18.5	0.140391442
Edinburgh Queen St	324500	674500	18.7	17.61325359	17.73529368	17.7	0.122040091
Edinburgh Roseburn	322500	673500	15.6	14.90818582	15.02333624	15	0.11515042

\*As available from [www.airquality.co.uk](http://www.airquality.co.uk)

Please note that we have used 8 decimal places simply to show the calculation – clearly this level of precision is not warranted in any final assessment of the results.

As can be seen by from the table, the overall difference in using the Scotland or UK maps is very small – maximum of 0.14µgm<sup>-3</sup>. Also, use of the Scottish maps would not have changed any predicted exceedence of the Scottish Air Quality Objective to a non-exceedence, or vice-versa

#### Measured vs. mapped concentrations at background monitoring sites.

Table 3.4 shows that the mapped (both UK and Scottish) concentrations for the grid square containing the Edinburgh St Leonards site agree closely with the measured concentration from the FDMS monitor at the St Leonards Monitoring site.

**Table 3.4 Comparison of measured and modelled PM<sub>10</sub> concentrations at St Leonards**

Site	Grid Ref. x	Grid Ref. y	2008 Monitoring data PM <sub>10</sub> µm <sup>-3</sup>	2008 concentration (using UK maps) PM <sub>10</sub> µgm <sup>-3</sup>	2008 concentration (using Scottish maps) PM <sub>10</sub> µgm <sup>-3</sup>
Edinburgh St Leonards	326500	673500	15	14.345317	14.18125382

#### Overall comparison of Scottish and UK maps for Edinburgh Area

Figure 3.5 shows a scatter plot of concentrations for all grid squares in the Edinburgh area comparing the results of the Scottish and UK mapping for 2007. As can be seen, the correlation is very good, with the Scottish results lying slightly lower than the UK wide results.

**Figure 3.5 Correlation plot of Scottish vs UK PM<sub>10</sub> maps for Edinburgh**

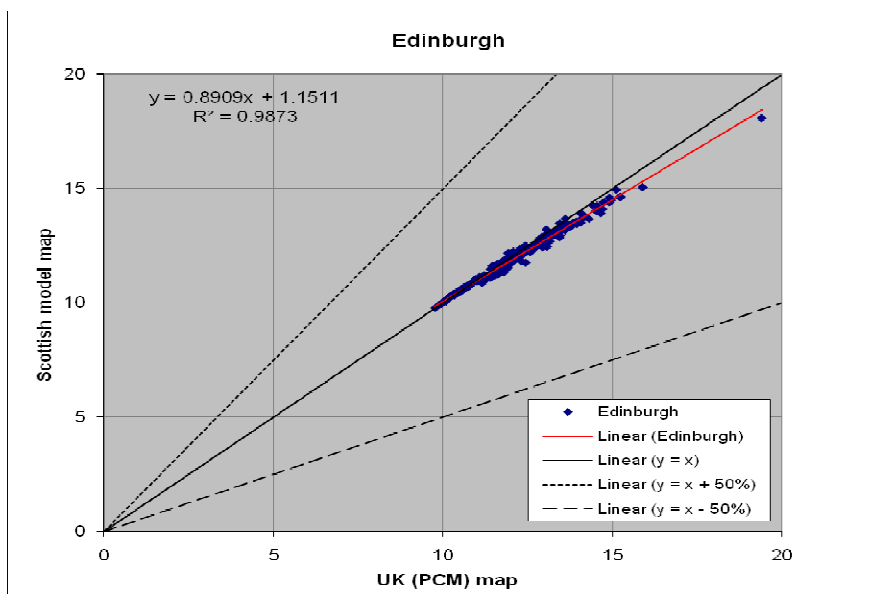
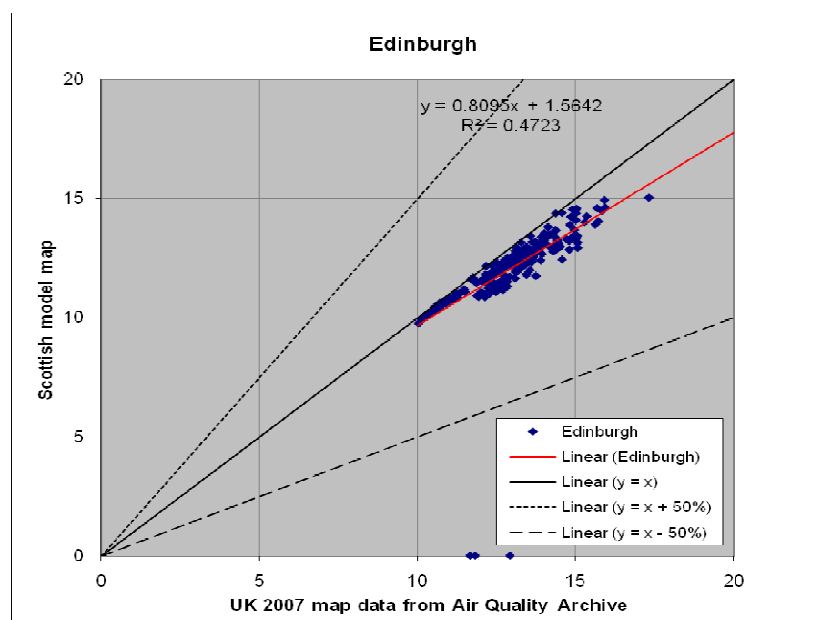


Figure 3.5 contains the latest available UK (PCM) map data based on 2007 UK wide mapping and hence reflects differences due to UK and Scottish mapping results only. However, due to the mismatch with the LAQM timetable, the UK map data available to Local Authorities on [www.airquality.co.uk](http://www.airquality.co.uk) are still data from 2006 map with a forward projection to 2007. Hence, whilst Figure 3.5 shows the difference due to UK and Scottish specific mapping alone, Figure 3.6 shows the difference between the UK maps available to Local Authorities on [www.airquality.co.uk](http://www.airquality.co.uk) and the corresponding Scottish maps for 2007.

**Figure 3.6 Correlation plot of Scottish vs UK map data from [www.airquality.co.uk](http://www.airquality.co.uk) for Edinburgh**



The correlation is still very good, and the difference is generally less than about  $1\mu\text{g m}^{-3}$ , with the Scottish map giving lower results.

### 3.4 East Renfrewshire

Based on the information obtained from the additional calculations on the Scotland Specific map data, forward projection calculations of Local Authority roadside monitoring site data for 2008, to 2010, have been calculated and compared with those determined from the of the UK maps and with those provided in the 2009 East Renfrewshire USA.

These data are summarised in Table 3.5.

**Table 3.5. Forward projection calculations for East Renfrewshire**

Site	Grid Ref. x	Grid Ref. y	2008 Monitoring data $\text{PM}_{10} \mu\text{m}^{-3}$	Projected 2010 concentration (using Scottish maps) $\text{PM}_{10} \mu\text{gm}^{-3}$	Projected 2010 concentration (using UK maps)* $\text{PM}_{10} \mu\text{gm}^{-3}$	LA calculated projected 2010 Concentration $\text{PM}_{10} \mu\text{gm}^{-3}$	Difference between UK and Scottish methods $\text{PM}_{10} \mu\text{gm}^{-3}$
E Renfrewshire Sheddens	257500	657500	17	15.95692226	16.10833217	15.9	0.151409904

\*As available from [www.airquality.co.uk](http://www.airquality.co.uk)

Please note that we have used 8 decimal places simply to show the calculation – clearly this level of precision is not warranted in any final assessment of the results.

As can be seen by from the table, the overall difference in using the Scotland or UK maps is very small.

Where background map data have been used in modelling work within the Detailed Assessment for Sheddons Roundabout then the background monitored data from the Waulkmillglen reservoir have been used as these are available on an hourly basis. Table 3.6 shows that there is about  $1\mu\text{gm}^{-3}$  difference between VCM corrected TEOM 2008 annual average measurements at Walkmillglen and UK map concentration (from [www.airquality.co.uk](http://www.airquality.co.uk)) for the corresponding grid square. The concentration based on the Scottish map is then about a further  $1\mu\text{gm}^{-3}$  lower.

**Table 3.6 Measured vs. mapped concentrations at background monitoring sites.**

Site	Grid Ref. x	Grid Ref. y	2008 Monitoring data $\text{PM}_{10} \mu\text{m}^{-3}$	2008 concentration (using UK maps)* $\text{PM}_{10} \mu\text{gm}^{-3}$	2008 concentration (using Scottish maps) $\text{PM}_{10} \mu\text{gm}^{-3}$
Glasgow Walkmillglen Reservoir	252500	658500	12.1	11.436812	9.96486038

\*As available from [www.airquality.co.uk](http://www.airquality.co.uk)

#### Overall comparison of Scottish and UK maps for East Renfrewshire

Figure 3.7 shows a scatter plot of concentrations for all grid squares in the East Renfrewshire area comparing the results of the Scottish and UK mapping for 2007. As can be seen, the correlation is very good, with the Scottish results lying slightly lower than the UK wide results.

**Figure 3.7 Correlation plot of Scottish vs UK PM<sub>10</sub> maps for East Renfrewshire**

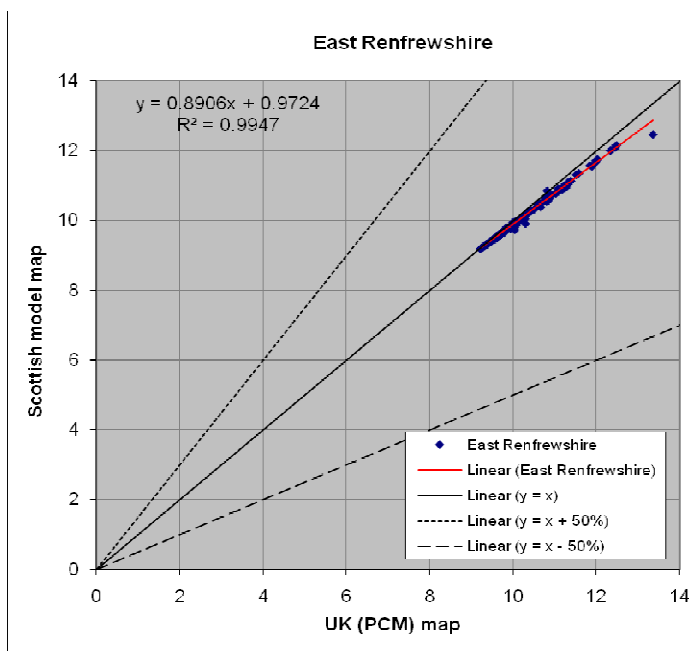
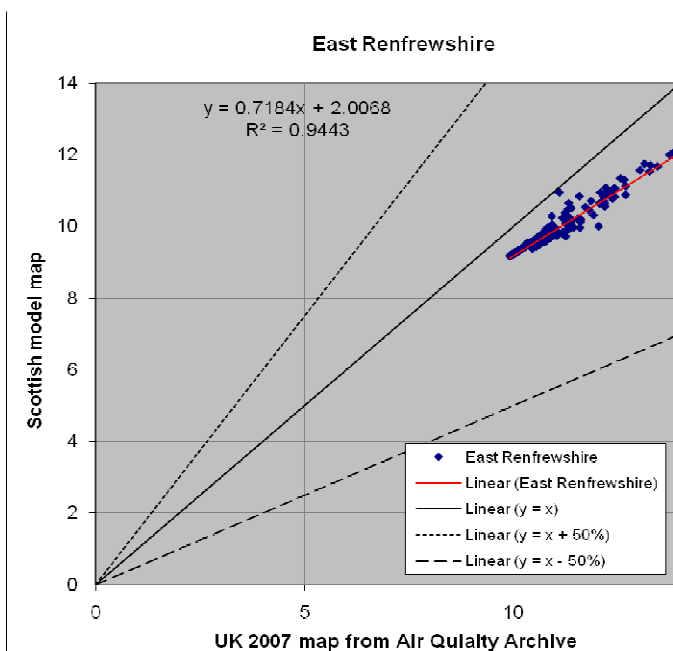


Figure 3.7 contains the latest available UK (PCM) map data based on 2007 UK wide mapping and hence reflects differences due to UK and Scottish mapping results only. However, due to the mismatch with the LAQM timetable, the UK map data available to Local Authorities on [www.airquality.co.uk](http://www.airquality.co.uk) are still data from 2006 map with a forward projection to 2007. Hence, whilst Figure 3.7 shows the difference due to UK and Scottish specific mapping alone, Figure 3.8 shows the difference between the UK maps available to Local Authorities on [www.airquality.co.uk](http://www.airquality.co.uk) and the corresponding Scottish maps for 2007.

**Figure 3.8 Correlation plot of Scottish vs UK map data from [www.airquality.co.uk](http://www.airquality.co.uk) for East Renfrewshire**



The correlation is still very good, and the difference is generally about  $1\mu\text{g}\text{m}^{-3}$ , with the Scottish map giving lower results.

## 4 Conclusions

The conclusions from this brief study can be summarised as follows:

- The main use of the background PM<sub>10</sub> maps by Local Authorities has been to roll forward 2008 measured concentrations to estimated 2010 concentrations for comparison with the Scottish Air Quality Objective
- To undertake this calculation, the source apportionment and forward projection factors are required for each square in addition to the mapped total PM<sub>10</sub> concentration. This breakdown of the total mapped PM<sub>10</sub> concentration has not been undertaken previously on a Scotland specific basis.
- However, use of the Scotland specific maps for forward projection in the 4 example authorities showed only very small differences compared to the use of the UK map data. These differences were generally smaller than rounding errors introduced when monitored concentrations are reduced to integer values.
- For comparison of Scottish and UK mapping methodology alone, the 2007 Scottish maps have been compared with UK (PCM) maps for 2007. These correlations show very little difference between the two techniques (generally less than 1µgm<sup>-3</sup>, with the Scottish map generally showing lower results)
- However, the UK map data available to Local Authorities on [www.airquality.co.uk](http://www.airquality.co.uk) are based on 2006 maps projected forward to future years. These are the only data available to Local Authorities at present and hence, in assessing the overall difference to Authorities in using Scottish map data for their 2007 Updating and Screening assessment, the comparison between the UK map data available on [www.airquality.co.uk](http://www.airquality.co.uk) and the Scottish map data have also been plotted. This shows slightly larger differences than between the mapping methodology alone (see above). The difference is more in the range 1-2µgm<sup>-3</sup>, again with the Scottish maps giving lower results.

The results of this investigation provide useful information to inform the discussion on the requirements for pollution mapping in Scotland in future years.



## **5 Acknowledgements**

AEA gratefully acknowledges the assistance and active participation in this study of the four Local Authorities involved – Glasgow, N. Lanarkshire, Edinburgh and East Renfrewshire.

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# Appendices

## Appendix 1:

Developing the Scottish map data for forward projection assessment

# Appendix 1

## Developing the Scottish map data for forward projection assessment

The current Scottish specific PM<sub>10</sub> maps for 2007 are based on Scottish PM<sub>10</sub> monitoring data and Scottish met data. This work provided total PM<sub>10</sub> concentrations for each grid square in Scotland. However, a breakdown of PM<sub>10</sub> for each grid square by source contribution and projections forward to other years from 2007 for the Scottish specific maps was not undertaken as part of the Scottish mapping exercise as these were not part of the agreed task at that time.

The current UK PM<sub>10</sub> maps provided for LAQM assessment are based on 2006 as a base year, but include breakdown into source contribution sectors and are projected forward annually to 2020 using sector specific emission scaling factors. Projections for road traffic emission are calculated in more detail and incorporate predicted geographic (e.g. Scotland) trends in traffic activity.

Discussion with the 4 trial Scottish Local Authorities, indicates that a key use that has been made of the PM<sub>10</sub> maps for LAQM assessment has been to estimate concentrations in 2010 from measured data in 2008. This process is undertaken using the method described in Box 2.2 of LAQM TG(09) (see Figure A.1) and requires the mapped PM<sub>10</sub> concentrations for 2008 and 2010 and the source breakdown for each of these years.

**Figure A.1. Methodology for projecting forward PM10 concentrations to future years.**

**Box 2.2: Projecting measured annual mean roadside PM<sub>10</sub> concentrations to future years**

Annual mean PM<sub>10</sub> concentrations at roadside locations in future years can be estimated from measured values using the following method. This method is only appropriate for roadside locations and cannot be used at locations where there is a strong influence from fugitive or industrial sources.

**Step 1:** Identify the total background concentration for the relevant grid square in µg/m<sup>3</sup>, for the measurement year from the national maps published at [www.airquality.co.uk](http://www.airquality.co.uk). (If the background concentration is more than that measured then project forward using the approach in paragraphs 2.02 to 2.08).

**Step 2:** Subtract the background concentration (Total\_PM<sub>10</sub>) for the appropriate year from the measured concentration to determine the local PM<sub>10</sub> road concentration in that year.

$$\text{measured} - \text{background} = \text{local road concentration}$$

**Step 3:** For the relevant grid square for the year of monitoring add together concentrations from the following road sources:

- Motorway\_in and Motorway\_out
- Trunk\_A\_Rd\_in and Trunk\_A\_Rd\_out
- Primary\_A\_Rd\_in and Primary\_A\_Rd\_out
- Minor\_Rd\_in and Minor\_Rd\_out
- Brake\_Tyre\_in and Brake\_Tyre\_out

$$\text{motorways} + \text{trunk A roads} + \text{primary A Roads} + \text{minor roads} + \text{brake \& tyre} = \text{background road contribution}$$

**Step 4:** Repeat step 3 for the future year.

**Step 5:** Divide the background road contribution in the future year by the background road contribution in the measurement year. The result is the "year adjustment factor".

$$\frac{\text{background road contribution in future year}}{\text{background road contribution in measurement year}} = \text{year adjustment factor}$$

**Step 6:** Multiply the local road concentration (from Step 2) by the adjustment factor (from Step 5) to determine the concentration from local road sources in the future year.

$$\text{local road measured} \times \text{adjustment factor} = \text{local road concentration in future year}$$

**Step 7:** Identify the local background concentration in the future year from the national maps published at [www.airquality.co.uk](http://www.airquality.co.uk).

**Step 8:** Add the local road concentration in the future year to the background concentration in that year to determine the total roadside concentration in the future year.

$$\text{local road concentration} + \text{background} = \text{Total PM}_{10} \text{ concentration}$$

Further assistance with this procedure and interpretation of the results can be obtained from the Review and Assessment Helpdesk (see Box 1.1).

As noted above, these data are not currently available from the Scottish mapping work undertaken thus far – and, it would be a considerable effort to undertake this work on a purely Scottish specific basis.

We have therefore proposed a compromise solution based on using the UK factors for annual projection and source breakdown applied to the Scottish base data. There may be differences in projecting forward from a 2006 (UK) base year compared to the 2007 (Scottish) base year but these are likely to be small. Also, whilst the projection factors for the local traffic contribution are almost certain to be the same for Scotland as for the UK, the projection forward from other sources may not be exactly the same. However, again these differences are likely to be small since the UK projections already incorporate variable policies across the UK, as far as these are available.

The likely largest difference – the difference between the UK and Scottish mapping of total background  $PM_{10}$  - is accounted for in the production of the Scottish specific maps and any uncertainties introduced by use of the proposed compromise projection method are likely to be very small.

This exercise therefore allowed the production, relatively quickly, of forward projections and source attribution using the Scottish PM maps.

#### **Detailed Methodology.**

The LAQM TG(09) method in Box 2.2 uses the UK background maps as follows:

- The mapped background concentration in 2008 is subtracted from the measured roadside concentration in 2008 to calculate the 2008 roadside increment.
- The contribution to background concentration in each grid square from road traffic sources is calculated for 2008 and 2010 and used to calculate a dimensionless scaling factor.
- This road traffic scaling factor is then applied to the 2008 roadside increment to calculate the 2010 roadside increment
- The mapped background for 2010 is then added to this to calculate the predicted roadside concentration in 2010.

The most important difference between the Scottish and UK background maps in the application of this method will be the total background concentration. This will change the source apportionment between the background and roadside increment, which will have different trends.

The trends in the roadside increment calculated from projected Scottish maps (if these were to be calculated) would be the same as those calculated from the UK maps because the input data are the same. Thus the dimensionless scaling factor used to project the roadside increment to 2010 would be the same.

The trend in background concentration between 2007 and 2010 predicted from projected Scottish maps would be likely to be very similar to that predicted by the UK maps. The main driver for a difference in background concentration prediction in 2010 would be the starting background concentration in 2007.

We have therefore carried out the following analysis to capture the key differences (the different source apportionment between background and roadside increment) without the need to carry out substantial new modelling work to derive other parameters which are unlikely to have a big impact on the results.

The UK maps were used to derive the following scaling factors on a grid cell basis:

Factor 1	Total background factor from 2007 to 2008
Factor 2	Total background factor from 2008 to 2010
Factor 3	Road traffic factor from 2008 to 2010

Factor 1 was then used to derive background estimates for 2008 from the 2007 Scottish background map. This background was used to calculate the roadside increment in 2008 and Factor 3 was used to scale this increment forward to 2010. Factor 2 was used to scale the Scottish background to 2010 and add the roadside increment to this to calculate the total roadside estimate for 2010.

Factor 1.

$$Factor\ 1 = \frac{2008\ total\ background}{2007\ total\ background}$$

By multiplying each grid of the 2007 Scottish Background map in question with its relevant Factor 1 we are able to estimate a total background concentration for Scotland for 2008

Factor 2.

$$Factor\ 2 = \frac{2010\ total\ background}{2008\ total\ background}$$

By multiplying each grid of the estimated 2008 Scottish Background map in question with its relevant Factor 2 we are able to estimate a total background concentration for Scotland for 2010.

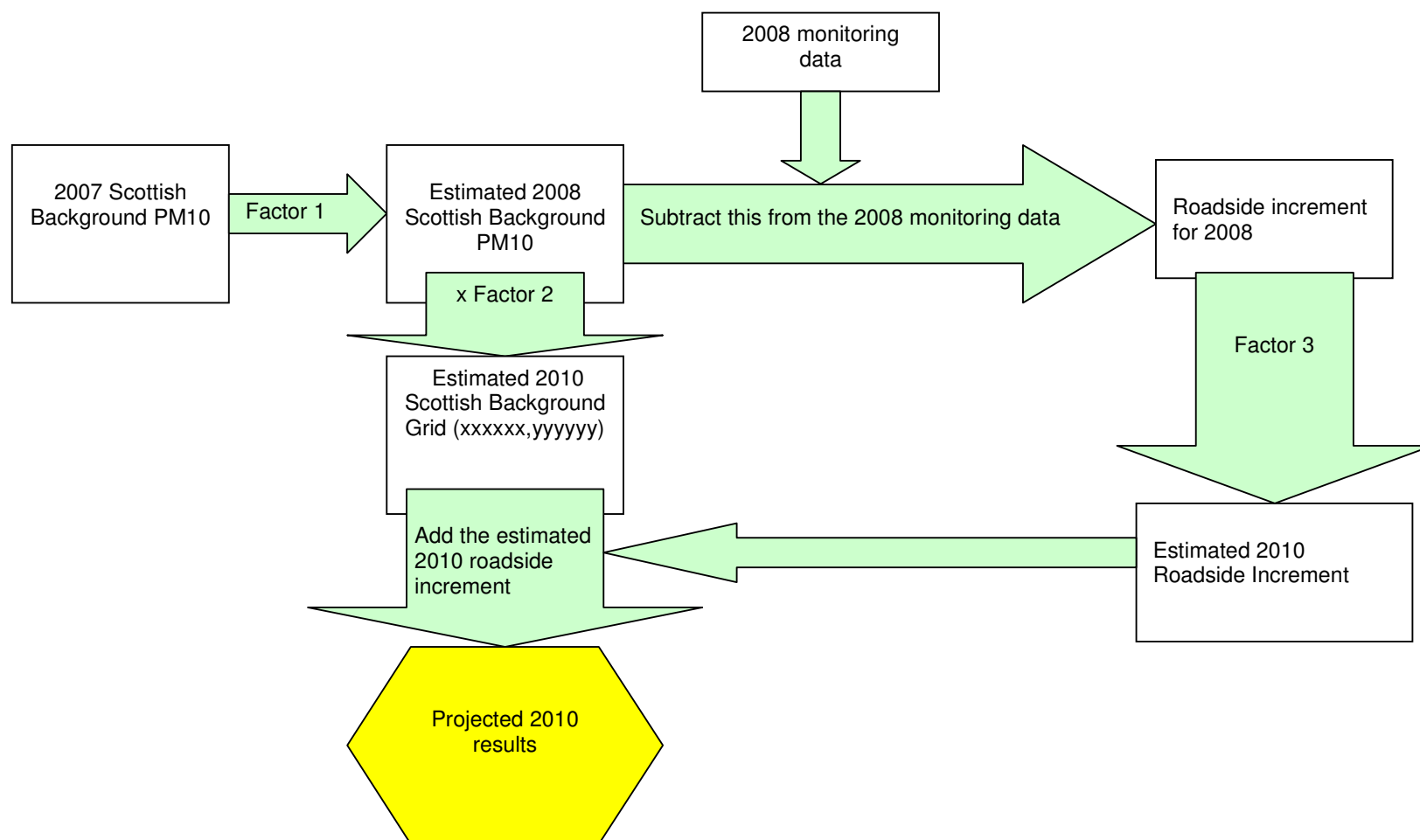
Factor 3.

$$Factor\ 3 = \frac{2010\ Total\ road\ traffic\ contribution}{2008\ Total\ road\ traffic\ contribution}$$

Factor 3 provides a factor on how much the road traffic contribution in each grid will change between 2008 and 2010.

The flow chart in Figure A2 shows the how these factors are used in projecting 2010 concentraions.

**Figure A.2. Flow chart showing calculation process**









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