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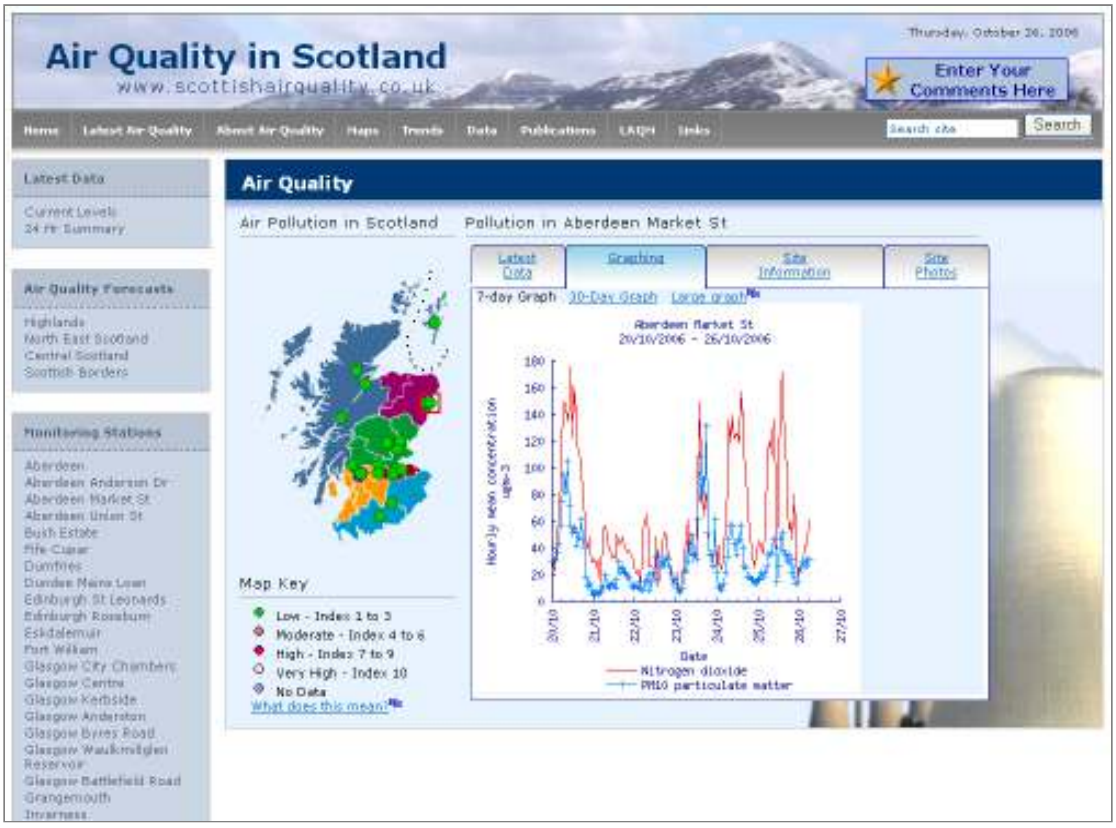

Pilot Study for a Scottish Air Quality Database
Final Report

Report to the Scottish Executive

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Executive Summary

AEA Energy & Environment has been commissioned by the Scottish Executive Climate Change and Air Division to carry out a Pilot Study for a Scottish Air Quality Database.

Until now air quality data in Scotland has been collected by a wide range of organisations for a number of purposes and has been widely dispersed. Experience across the rest of the UK has indicated that a comprehensive centralised resource providing air quality information for Scotland may improve the quality of research and data analysis required to support Scottish air quality policies. The Scottish database would operate in the context of other UK resources - The UK Air Quality Archive, The Air Quality Database for Wales and The Northern Ireland Air web site.

By commissioning a pilot study the Scottish Executive has aimed both to learn from the experience of these other projects, and to explore with stakeholders the potential requirements and applications for an air quality database for Scotland.

This report presents the findings of the project - summarised as follows:

- The pilot study air quality web site and database was successfully developed and is available to review online at http://www.scotarc.aeat.com:
  user name - scotarc
  password - w3bsite

- A series of stakeholder meetings and seminars were held to introduce the project and review the requirements and outcomes. The meetings involved the Scottish Executive, SEPA, local authorities, NHS, CBI Scotland, SCIEH, SNH, RSS, Forestry Commission and others. The response was extremely positive, with local authorities, policy makers and statistical experts all indicating that an online central resource for Scottish air quality information would be extremely beneficial.

- A review of the extent and quality of air quality data across Scotland determined that within the national networks over 90 pollutant species are monitored, but at a relatively small number of monitoring sites. Monitoring undertaken by Local Authorities is much more extensive in terms of geographical coverage and site numbers (83 automatic sites and over 800 diffusion tube monitoring sites). It is recommended that a system to harmonise the quality of these data across Scotland should be introduced.

- Air Quality mapping and trends analyses were carried out on the data gathered for the pilot study database. Both of these studies identified improvements on the existing national scale studies based on National Monitoring Network data only. Both also concluded that results would be improved by gathering of further additional data to the database in future years in order to provide a more complete picture of the current and future air quality climate for Scotland. Now that the methodologies have been developed these analyses should be easier to carry out in the future.

- An evaluation of the new commercially available Weblogger technology for automatic data acquisition from air pollution monitoring sites over the internet was carried out. The system was found to work successfully with potential savings in time and effort to be achieved by some local authorities depending on their individual requirements.

Contents

1 Introduction

AEA Energy & Environment has been commissioned by the Scottish Executive Climate Change and Air Division to carry out a Pilot Study for a Scottish Air Quality Database.

Until now air quality data in Scotland has been collected by a wide range of organisations for a number of purposes and has been widely dispersed. Experience across the rest of the UK has indicated that a comprehensive centralised resource providing air quality information for Scotland may improve the quality of research and data analysis required to support Scottish air quality policies. The Scottish database would operate in the context of other UK resources:

- The UK Air Quality Archive, www.airquality.co.uk. Sponsored by Defra and the Devolved Administrations since the mid 1990s and already containing data from national monitoring sites in Scotland.
- The Air Quality Database for Wales, www.welshairquality.co.uk. Operated on behalf of the National Assembly for Wales and Welsh Air Quality Forum since 1998.
- The Northern Ireland Air web site, http://www.airqualityni.co.uk. Operated on behalf of the Northern Ireland Department of Environment, Environment and Heritage Service since July 2006.

By commissioning a pilot study the Scottish Executive aimed both to learn from the experience of these other projects, and to explore with stakeholders the potential requirements and applications for an air quality database for Scotland.

The specific aims and objectives of the project were as follows:

1. To design and populate a pilot air quality database for Scotland.
2. To be creative in designing a website which enables easy access to air quality data for a wide variety of potential users.
3. To assess the quality and variety of air quality data collected across Scotland and evaluate its compatibility.
4. To trial Web Logger technology on 6 suitable Local Authority sites (in collaboration with Air Monitors Ltd).
5. To liase with stakeholders and gain their views on requirements of a database. This should include local authorities, SEPA, and environmental health bodies in Scotland.
6. To develop tools to efficiently map air quality across Scotland and to ensure trend data can be easily derived from the Air Quality Archive.

The following sections of this report provide details of the work carried out to deliver the pilot study database and to meet the required objectives.

2 Database and Website Design

One of the major objectives of this project was to design a pilot study database and web site which would hopefully act as the central repository for Scottish air quality data for the foreseeable future. We believed that there were two separate and very different aspects to this task:

1. Designing a database which was based on the solid and reliable technology used for other air quality archives. This would need to allow rapid and unrestricted access to the data, be easily expandable to add more sites and pollutants, and have the necessary reliability and back-ups to ensure that the database was always available and accurate.
2. Using a more creative approach to design an attractive web site to act as the public front-end to the database. The web site would need to have a reasonably simple home page so that less technical users could understand the information, whilst also providing easy access to the more detailed technical information for government bodies, researchers, consultants and local authorities.

The results of the pilot study are described in more detail below and can also be viewed online at http://www.scotarc.aeat.com:

user name - scotarc
password - w3bsite

2.1 DATABASE DESIGN

The Scottish Air Quality Database is key to the efficient, rapid and reliable operation of the overlying public information website. Drawing on our extensive and successful experience in developing the UK Air Quality Archive, which holds over 150 million air quality data records on line, we have designed a similar but separate Air Quality Database for Scotland. For the pilot study all historical Scottish data from the UK Air Quality Archive and AEA Calibration Club have been loaded to the database. In addition, real-time data from automatic monitoring sites available to AEA Energy & Environment and Air Monitors Ltd were collected and appended to the database daily and made available on-line.

The database is fully relational and stores both data and derived information from monitoring networks, parameters and monitoring sites in Scotland, together with historic, current and forecast data.

All database uploads, downloads and statistical calculations are controlled by our proven and reliable data management system; this consists of a range of data processes that ensure that any data received are correctly formatted and checked prior to acceptance by the archive database.

Figure 2.1 shows in simplified form the system architecture for the management and dissemination of air quality information. The main functional elements of the system are:

1. **AEA Scottish air quality database -** Raw data from automatic and non-automatic monitoring sites are stored before being uploaded to the online Air Quality Archive Databases. This database is securely backed up.
2. **Online Master Air Quality Database** – This is the main database holding air quality data from all automatic and non-automatic sites.
3. **Mirror Air Quality Database** - A mirror of the master database is synchronised to the master database.
4. **Backup Air Quality Database** - A full backup copy of the master database is made overnight. If required, this can be used to quickly recover from any serious failure of the main database server- thereby maximising system availability at all times.
5. **Archive web server** - The database is run from a server that can be accessed through the World Wide Web. This is the Master Air Quality Archive Database's 'window' to the outside world, which displays all the dynamic Archive web pages.
6. **Mirror Archive Web Server** - This allows load-sharing between web servers. In times of peak activity on the web site, the mirror site and database will be automatically and seamlessly used to spread the load of page and data requests, thereby maintaining efficient and speedy access to data and information for all users.
7. **Forecasting** – Forecast data and information for Scotland are provided by linking to the national forecasting database, which is currently managed by AEA in collaboration with the Met Office.

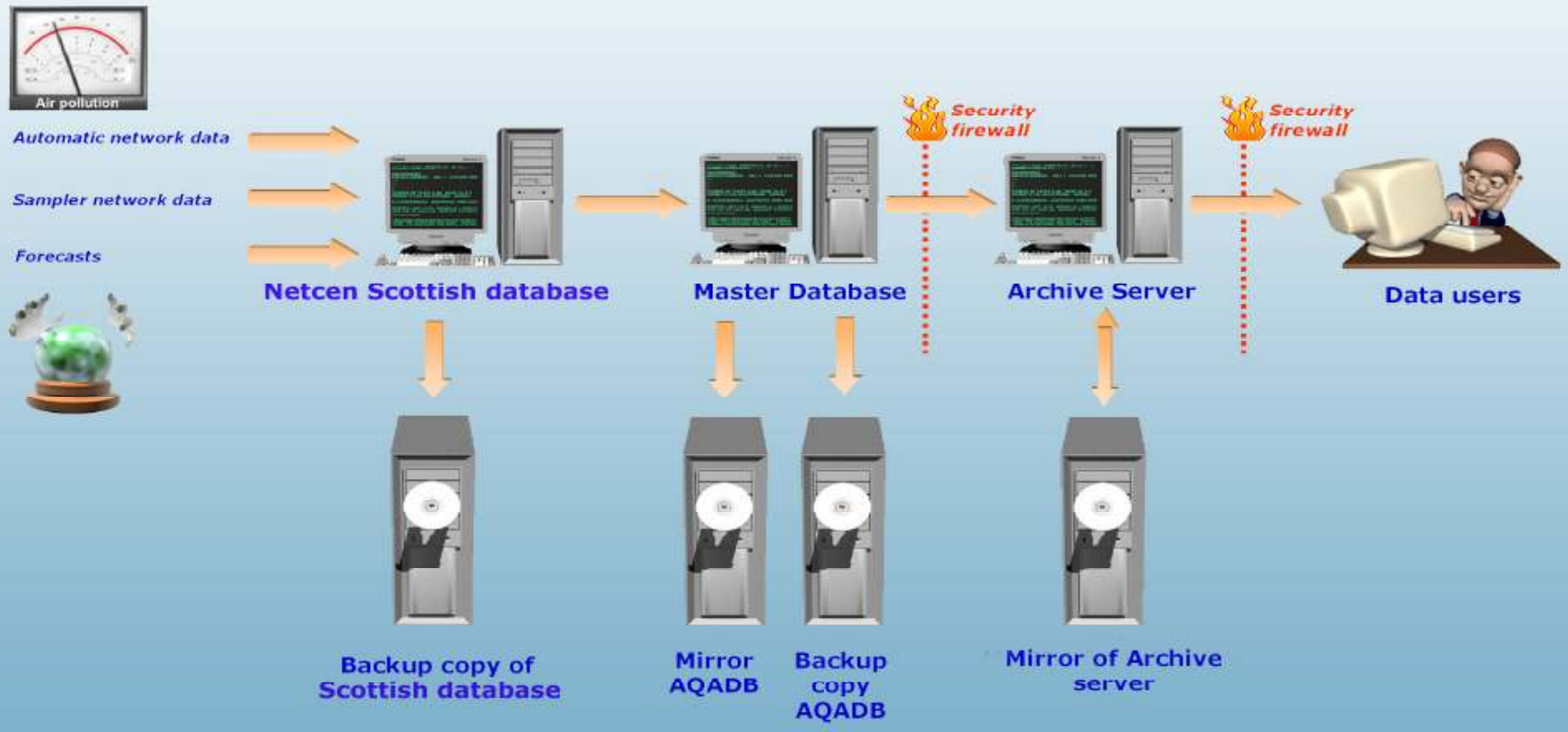
Several different programming languages have been used in the development including C, C-shell, borne-shell, AWK, PERL, ANSI92-SQL and MYSQL-extensions. The entire system is based on technologies and practice proven extensively in service for the UK, Wales, Northern Ireland and Gibraltar Air Quality Archives - and other major air quality websites. This robust approach offers rapid data throughput, extremely high availability and security at all times.

2.1.1 Real-time data acquisition

All data received from the AURN and other Scottish monitoring stations are automatically appended to the AEA Scottish air quality database and subsequently uploaded to the online Pilot Study Scottish Air Quality Archive Database and web site
Automatic data acquisition for this project can be split into two separate work areas:

1. AEA's existing data management systems are used to acquire and screen data from the Scottish automatic air quality monitoring stations. Our software is able to communicate with a wide range of data logging technologies. The system has been proven over many years to provide rapid high quality data from large UK and overseas national monitoring programmes.
2. The investigation of the use of Web Logger technology. This aspect of the work is described fully in section 4 of this report.

Figure 2.1 Overall system components and data flow through the Scottish Air Quality Database



2.1.2 Non-automatic monitoring data

Data management for non-automatic measurements is different to that for automatic sites. The Scottish local authorities are responsible for procurement, exposure and analysis of the NO_2 diffusion tubes which are the main results of interest. For the purposes of the pilot study database we have taken a copy of all the non-automatic monitoring data for Scotland currently in the UK Air Quality Archive and made that available through the Scottish database. For future operation we propose that the NO_2 diffusion tube results will be provided to AEA through the use of the web-based data entry system currently used for UK NO_2 data collection. Over 60% of the Local Authorities in Scotland are already familiar with this system which provides for the direct entry of non-automatic data to the archive via on-line forms on a web page. By setting up a direct link from this software to the Scottish database we will ensure that the UK and Scottish databases are synchronised. This approach has been shown to offer significant logistical and cost advantages over alternative manual systems.

2.1.3 Data checking

The objectives of the Database and Website can only be met fully if the data and derived information are both accurate and reliable.

For the pilot study Scottish database we have set up systems for both automatic data flagging and data inspection by our experienced monitoring experts, to ensure that:

1. Anomalous or incorrect data are identified and flagged early.
2. Site operators are advised promptly so that remedial action can be taken.
3. Incorrect data are not permitted to propagate through the system or be disseminated externally.

The systems are based on our extensive data management and QA/QC experience which we already implement in Scotland through our Calibration Club, quality assurance management of the AURN monitoring sites and management of non-automatic sampler networks. They enable us to detect faults such as:

- Negative or excessively high data.
- Constant output results.
- Data gaps.
- Faulty calibrations.

Our full review of the current availability and quality of air monitoring data in Scotland is presented in section 3 of this report. The main recommendation is that only data with a proven QA/QC scheme are added to the Scottish Air Quality Database, otherwise any conclusions drawn from the real-time data reporting or subsequent data analysis may prove to be spurious.

2.1.4 Data Archival

The pilot study Scottish database has been configured so that the data management system is continuously in standby mode, searching for incoming data: any new data thus automatically triggers activation of the relevant data archival process. This includes data received from any of the data suppliers including the air quality forecasts, or a request to update information (such as a monitoring site change).

Different data processes are able to run in parallel, so that the system will cope effectively with any external disruptions. Should an event fail, the system design ensures that there are no knock-on impacts or delays to other actions. By using such an event-driven system, all the tasks become modular. This approach offers

an additional advantage: the system is flexible, and additional or amended tasks are easily integrated into the data throughput simply by defining and coding the individual tasks and specifying the event that triggers them.

This system design also allows us to guarantee almost instant (within 1 to 2 minutes) dissemination of information from its time of receipt. Moreover, should any one route fail, this will not impede the dissemination of data via other routes. Should any event fail, an appropriate message is automatically sent to the system administrators via e-mail and SMS text message, ensuring that any problems can be addressed as soon as possible.

The database contains a range of normalised tables in which measurement data, monitoring site and network details are recorded. All other records required to support the web-based functions are also stored in the database. e.g. ratification status and units. Provisional (i.e. checked, but not fully ratified) data in the Archive are clearly distinguished from fully validated data.

The design of the database ensures that the system is flexible and scaleable for future growth.

2.2 WEBSITE DESIGN

The pilot study website has been designed to be attractive with a clearly Scottish identity. It is based on a clear design principle: simple information with user-friendly data summaries and maps are presented at the 'front-end' of the site, and targeted mainly at public or Local Government end-users. As users click on links from the homepage, they gain progressive access to more detailed data and analyses; these are more likely to prove relevant to technical, policy, planning and regulator communities.

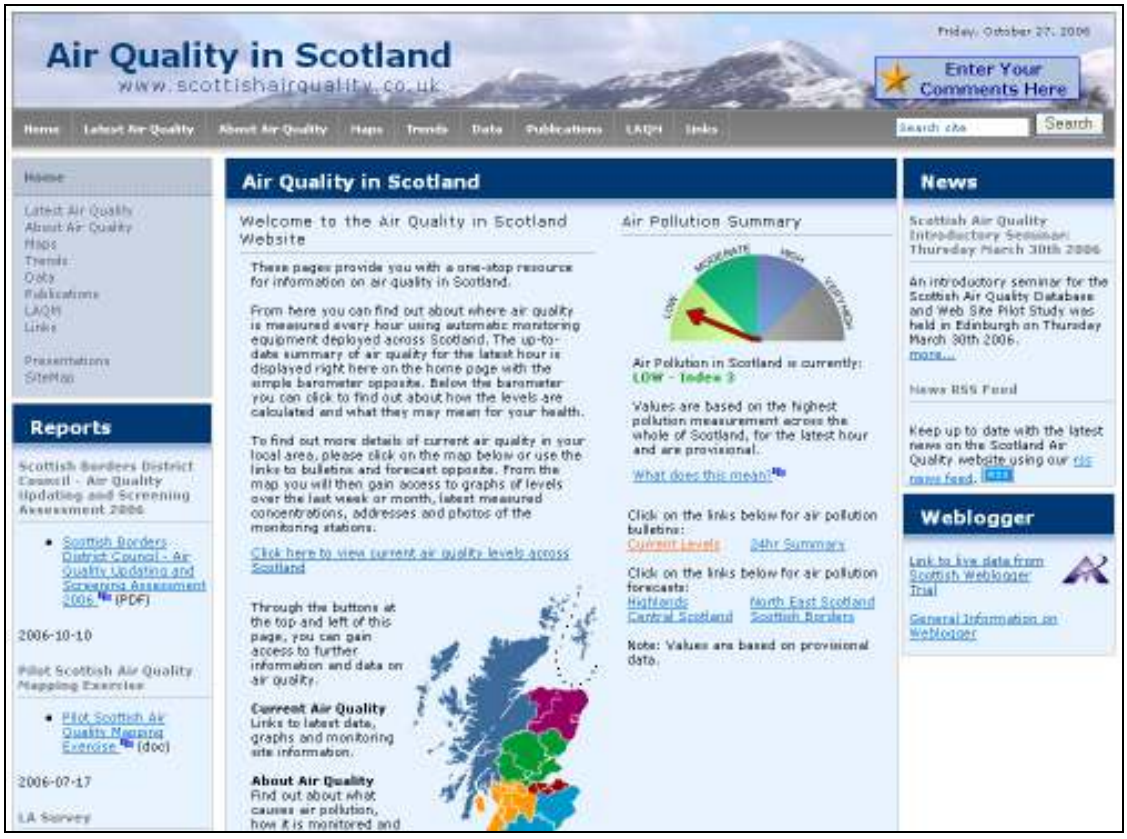
The web site is organised into clear sections according to functionality and user needs. The main components and functions of each of the sections are examined in more detail below.

2.2.1 The Home Page

The home page is designed to provide a simple introduction for the majority of users; it includes as a central feature a simple barometer of the latest up-to-date pollution levels across Scotland. This is based on the worst-case of all the automatic monitoring data supplied to the web site. Data are updated hourly for AURN automatic monitoring sites and daily for all others. Below the barometer the full listing of latest measurements and a forecast can be easily obtained by clicking on the links.

The rest of the home page provides some background information on the project, latest news and reports and links to the remainder of the website content. An illustration is provided in Figure 2.2 overleaf.

Figure 2.2 – Illustration of "Air Quality in Scotland" Home Page



2.2.2 Latest Air Quality

The central feature of the "Latest Air Quality" section of the web site is a colour-coded interactive map of the latest up-to-date pollution levels throughout Scotland. This gives users simple and summarised information – at a glance - on the current status of air quality throughout the region. The map provides information from the twenty-eight automatic monitoring stations (AURN & others) for which information was made available to the project. As an alternative to the map and for those who are not familiar with the geographical layout of Scotland, a full list of monitoring sites is also provided on the left-hand side of the page.

The map and the site list are highly interactive, allowing users to view air pollution band and index point, latest measurement data, seven and thirty-day graphs and monitoring site details, including photographs, simply by clicking a site on the map or the list and selecting one of several tabbed options. Please see Figure 2.3 overleaf for an example of the page with graphs and site location photos selected for Bush Estate

Latest data and air quality forecasts for all regions are also easily available by clicking the links on the far-left of the page.

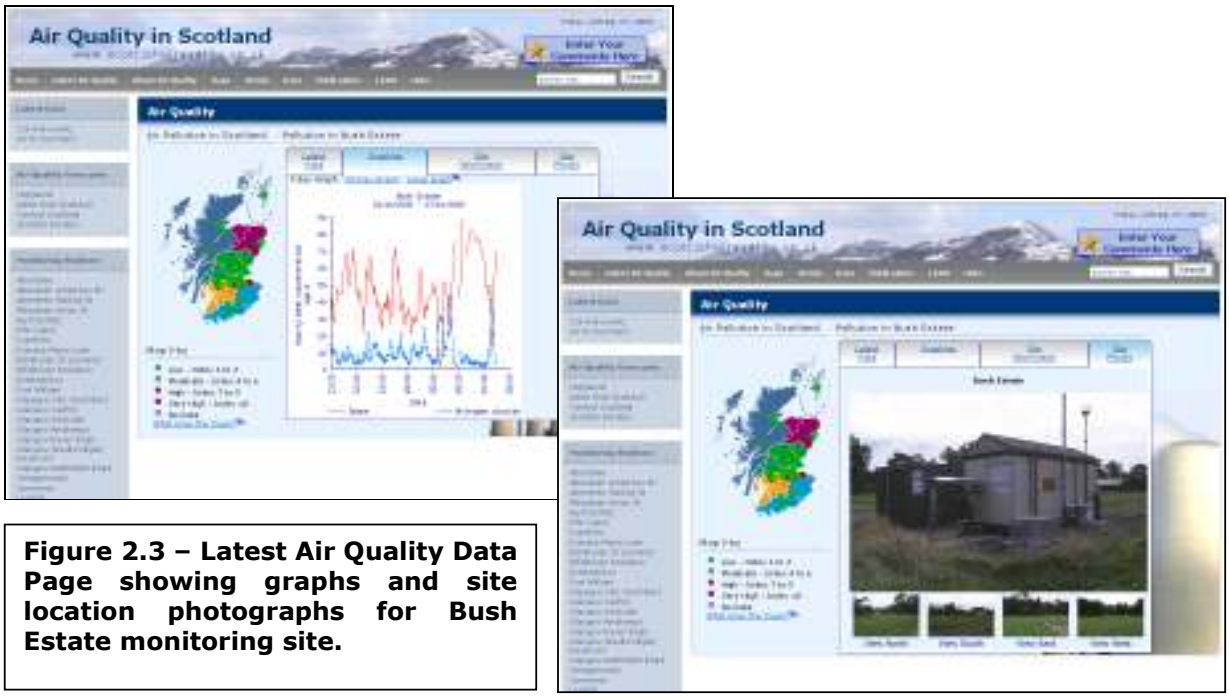


Figure 2.3 – Latest Air Quality Data Page showing graphs and site location photographs for Bush Estate monitoring site.

2.2.3 About Air Quality and Links

These areas of the website include a wide range of air quality information designed to raise awareness of both generic and local issues. The following topic areas are covered:

1. The UK Air Quality Strategy and Scottish Air Quality Regulations
2. EU Framework and Daughter Directives, CAFE and emerging policy context
3. Sources and characteristics of air pollutants
4. Environmental, ecosystem and health impacts
5. Monitoring techniques
6. Useful links to national and international information sources on air quality

Information is presented primarily with the general public in mind, giving links to more detailed explanations or technical information where appropriate.

2.2.4 Maps and Trends

These two sections of the website present the work which was carried out to meet these specific objectives of the contract. Technical details of the mapping and trends analysis are provided in section 6 of this report.

2.2.5 Data

All measured data are made freely accessible to users via this section of the web site. Local authorities, consultants and researchers are expected to make great use of this facility. Users are able to access data from the Archive in a variety of ways, depending on their precise requirements:

1. For small data selections the results can be viewed on screen, and then copied and pasted to a spreadsheet or word processing programme if required.
2. For larger data selections of several pollutants and/or sites and over a number of weeks or months the user can choose to have the results sent to them by e-mail. In most cases the results should be available in spreadsheet compatible CSV format within just a few seconds.

3. For data selections of many sites/pollutants and years which would create too large a file to e-mail, users will receive a message asking them to link to an ftp site where the CSV files can be easily downloaded.
4. If the user selects a data set which will be too large to load into a spreadsheet then a warning message is displayed and it is suggested that a smaller data selection is made. This prevents the database from being blocked by large data downloads which have been selected by mistake.

Data are available through a series of menus which allow sites, dates and parameters of interest to be selected. Warning messages also appear to indicate if there are no results available for a particular selection.

AEA staff regularly check the web site each day, to ensure that the information provided is up-to-date.

2.2.6 Publications

This section of the web site is database driven and provides the facility for any news, guidance or reports relevant to air quality in Scotland (or elsewhere) to be loaded for public download.

Reports are generally provided in PDF format but other Microsoft files are also possible. Links to web sites where the relevant document viewers can be found are provided here to ensure full public access is available:

PDF - Acrobat Reader
Download Acrobat Reader

DOC - MS Word Viewer
Download MS Word Viewer

XLS - MS Excel Viewer
Download MS Excel Viewer

PPT - MS Powerpoint Viewer
Download MS Powerpoint Viewer

2.2.7 Local Air Quality Management

A section of the web site (see illustration in figure 2.4 below) is devoted to LAQM information and tools. This is based on an interactive map of Scotland showing Local Authorities that have declared Air Quality Management Areas; users can also easily switch to an alternate view showing Authorities that have smoke control areas. The map is colour-coded so that users can easily identify at a glance which areas have declared air quality management and smoke control areas. Full details of AQMAs, action plans and smoke control areas can be found by selecting a Local Authority on the map or using the drop-down selector. A comprehensive list of Local Authority review and assessment reports will be made available from here, but for the purposes of the Pilot Study web site this has not been fully populated.

Figure 2.4 – Illustration of LAQM web pages

The map and associated data will be automatically updated, based on the latest information from the UK LAQM and Smoke Control Area databases currently maintained jointly by AEA and UWE. This will ensure immediate updating of the latest information and help minimise maintenance costs associated with this part of the site.

This area of the site also includes technical guidance and policy documentation from the Scottish Executive and SEPA, together with a series of Frequently Asked Questions on LAQM. The site also includes links to the comprehensive range of web-based assessment tools made available to Local Authorities by Defra and the Devolved Administrations.

3 Review of the Quality and Variety of Air Quality Monitoring Data in Scotland

To address this task, AEA first used the information collected by the Scottish Executive in 2005 on both National and Local Authority air quality monitoring in Scotland. The National information was essentially complete, but needed updating with recent changes. A summary of this information is provided in Section 3.1.

The information from Local Authorities was less complete and hence, AEAT contacted all 32 Local Authorities in Scotland directly to update and complete the information. This information focuses primarily on the monitoring of sulphur dioxide (SO_2), nitrogen dioxide (NO_2), carbon monoxide (CO), ozone (O_3) and particulate matter (PM_{10}) with automatic analysers and NO_2 by diffusion tube samplers. Monitoring undertaken by Local Authorities is presented and discussed in Sections 3.2.

3.1 NATIONAL NETWORK MONITORING IN SCOTLAND

Considerable monitoring of a wide range of air pollutant species is undertaken by the Scottish Executive as part of joint national programmes run in conjunction with Defra, the Welsh Assembly Government and the Department of the Environment in Northern Ireland. This monitoring includes statutory monitoring of all pollutants covered by EU Air Quality Directives as well as background monitoring of a much wider range of pollutants covered by international protocols and conventions. Some of these background sites are also part of the Europe-wide network co-ordinated by the Cooperative Programme for Monitoring and Evaluation of the Long-range Transmission of Air Pollutants in Europe (EMEP).

Table 3.1 summarise the number of monitoring sites in Scotland for each species (or group of species).

Table 3.1. Scottish Executive monitoring sites for major pollutants in Scotland

Pollutant	Site numbers	Areas covered	Network
Nitrogen Dioxide (NO_2)	10 (Automatic)	Mostly urban	1
Ozone (O_3)	9 (Automatic)	Urban and rural areas	1
Particles (PM_{10})	3 (PM_{10}-Gravimetric) 5 (PM_{10}-TEOM)	Mostly urban	1
Sulphur Dioxide	4 (Automatic)	Mostly urban	1
Carbon Monoxide (CO)	8 (Automatic)	Urban	1
Volatile Organic Compound (VOCs)	1 (Automatic, benzene) 1 (Automatic – multi species) 2 (Non-Automatic, benzene)	Urban Rural Urban	2 2 3
Polycyclic Aromatic Hydrocarbons (PAHs)	3 (Non-Automatic)	Industrial and urban	4
Metals- Pb, Cd, As, Ni and Hg	3 (Non-Automatic) 4 (Non-Automatic- rural deposition)	Industrial, urban Rural	5 6
Acid Deposition	11 (Non-Automatic rainwater)	Rural	7
Ammonia	26 (Non-Automatic)	Rural	8
Nitric Acid	4 (Non-automatic)	Rural	8

Key:	Network number	Network name	Current contractor
	1	Automatic Urban and Rural Network	BV/AEA
	2	Automatic Hydrocarbon Network	AEA
	3	Non-automatic Hydrocarbon Network	NPL
	4	PAH Monitoring in the UK	AEA
	5	Heavy Metals Monitoring Network	NPL
	6	Heavy Metal Deposition in the UK	CEH
	7	Acid Deposition Monitoring Network	AEA
	8	Ammonia and Nitric Acid Monitoring Network	CEH

3.1.1 Automatic Urban and Rural Network

The Automatic Urban and Rural Monitoring Network (AURN) consists of 125 monitoring stations throughout the UK – 14 of these stations are located in Scotland – See Table 3.2. Within the AURN, hourly measurements are undertaken for NO_2, CO, SO_2, O_3 and PM_{10} particles and, at some sites daily PM_{10} measurements are undertaken with gravimetric samplers. All of these data are available on the Scottish Air Quality website.

To better assess PM_{10} and $PM_{2.5}$ concentrations in Scotland, the Scottish Executive are currently deploying a further 8 Partisol monitors at existing AURN sites as follows:

Bush Estate	PM_{10} and $PM_{2.5}$
Dumfries	$PM_{2.5}$
Eskdalemuir	PM_{10} and $PM_{2.5}$
Fort William	PM_{10} and $PM_{2.5}$
Inverness	$PM_{2.5}$

Table 3.2. AURN Measurement Sites in Scotland

Site Name	Site Type	Species Measured	Grid Reference
Aberdeen	URBAN BACKGROUND	CO NO NO_2 NO_X O_3 PM_{10} SO_2	394416,807408
Auchencorth Moss	RURAL	O_3 PM_{10}(grav) $PM_{2.5}$(grav)	322000,656200
Bush Estate	RURAL	NO NO_2 NO_X O_3	324500,663500
Dumfries	ROADSIDE	CO PM_{10}(grav) NO NO_2 NO_X	297012,576278
Edinburgh St Leonards	URBAN BACKGROUND	CO NO NO_2 NO_X O_3 PM_{10} SO_2	326200,673100
Eskdalemuir	RURAL	NO NO_2 NO_X O_3	323500,602800
Fort William	RURAL	NO NO_2 NO_X O_3	210830,774410
Glasgow Centre	URBAN CENTRE	CO NO NO_2 NO_X O_3 PM_{10} SO_2	258902,665028
Glasgow City Chambers	URBAN BACKGROUND	CO NO NO_2 NO_X	259528,665308
Glasgow Kerbside	KERBSIDE	CO NO NO_2 NO_X PM_{10}	258708,665200
Grangemouth	URBAN INDUSTRIAL	CO NO NO_2 NO_X PM_{10} SO_2	293840,681032
Inverness	ROADSIDE	CO PM_{10}(grav) NO NO_2 NO_X	265720,845680
Lerwick	RURAL	O_3	445337,1139683
Strath Vaich	REMOTE	O_3	234700,875000

3.1.2 Automatic Hydrocarbon Monitoring Network

Automatic hourly measurements of the Air Quality Strategy pollutants benzene and 1,3-butadiene are undertaken within the UK Automatic Hydrocarbon Monitoring Network. In addition, at one rural site in Scotland (Auchencorth Moss), hourly measurements are undertaken of 26 hydrocarbon species both as an EU requirement to monitor these ozone precursor species and as part of the EMEP long-range transboundary air pollution monitoring programme.

Table 3.3. Automatic Hydrocarbon Network Sites in Scotland

Site Name	Site Type	Species Measured	Grid Reference
Auchencorth Moss	RURAL	Benzene and 1,3-butadiene and 24 other hydrocarbon species	322000,656200
Glasgow Kerbside	KERBSIDE	Benzene and 1,3-butadiene	258708,665200

3.1.3 Non Automatic Hydrocarbon Monitoring Network

Measurements of benzene concentrations integrated over a two-week period are undertaken at the Grangemouth and Edinburgh St Leonards AURN stations as part of the Non-automatic Hydrocarbon Monitoring network. Passive sampling of 1,3-butadiene is also undertaken at Grangemouth.

3.1.4 PAH Monitoring Network

There are three PAH monitoring locations in Scotland, details of which are provided in Table 3.4. Measured species are listed in Table 3.5.

Table 3.4. PAH Monitoring Sites in Scotland

Site	Address	Grid Reference
Edinburgh	West Richmond Street Gardens	326282,673125
Glasgow	20 Cochrane Street Glasgow G1 1RN	259422,665275
Kinlochleven 2	Electrical Substation Kinlochleven	219305,761905

Table 3.5. Species measured at PAH sampler locations

Acenaphthene, Acenaphthylene, Anthanthrene, Anthracene, Benzo(a)anthracene, Benzo(b)fluoranthene, Benzo(j)fluoranthene, Benzo(k)fluoranthene, Benzo(b)naph(2,1-d)thiophene, Benzo(ghi)perylene, Benzo(c)phenanthrene, Benzo(a)pyrene,	Benzo(e)pyrene, Chrysene, Cyclopenta(c,d)pyrene, Dibenzo(ah/ac)anthracenes, Dibenzo(ae)pyrene, Dibenzo(ah)pyrene Dibenzo(ai)pyrene, Dibenzo(al)pyrene, Fluoranthene, Fluorene, Indeno(123cd)pyrene, 1-Methyl Anthracene,	2-Methyl Anthracene, 9-Methyl Anthracene, 5-Methyl Chrysene, 1-Methyl Phenanthrene, 2-Methyl Phenanthrene, 4,5-Methylene Phenanthrene, Perylene, Phenanthrene, Pyrene, Retene,

3.1.5 Heavy Metals Monitoring Network

The Heavy Metals Monitoring Network has two urban and one rural measurement sites in Scotland (Table 3.6). At each of the sites, 12 metallic elements are measured. Details of these sites are provided in Table 3.6.

Table 3.6. Heavy Metals Monitoring Network Sites in Scotland

Site	Site type and grid ref	Address	Metals measured
Eskdalemuir	Rural 323500,602800	The Met Office Eskdalemuir Observatory, Langholm, Dumfries & Galloway, DG13 0QW	As, Cd, Cr, Cu, Fe, Hg[Vap + Part], Mn, Ni, Pb, Pt, V, Zn
Glasgow	Urban Background 261337,664435	Glasgow, St Annes, St Annes Primary School, 37 David Street Glasgow G40 2UN	As, Cd, Cr, Cu, Fe, Hg[Vap + Part], Mn, Ni, Pb, Pt, V, Zn
Motherwell	Urban Background 275764,656282	Civic centre, Motherwell	As, Cd, Cr, Cu, Fe, Hg[Vap + Part], Mn, Ni, Pb, Pt, V, Zn

3.1.6 Heavy Metal Deposition Monitoring Network

Concentrations of the metals As, Cd, Cr, Cu, Ni, Pb, Se, V, Zn, Al, Sc, Ti, Mn, Fe, Co, Rb, Sr, Mo, Sn, Sb, Ba and W are determined in rainwater collected samples at 4 stations in Scotland as part of the Rural Metal Deposition Monitoring Network. At 2 sites Banchory and Auchencorth Moss measurements are also made in collected particulate material. At Bowbeat in the Scottish Borders

measurements are also made in cloudwater samples. Mercury is also monitored in air and rain at Banchory and Auchencorth Moss. These measurements are summarized in Table 3.7.

Table 3.7. Rural Metal Deposition Monitoring sites in Scotland

Site	Location Grid Ref.	Heavy metals			Mercury	
		In Particles	In Rain	In Cloud	In Air	In Rain
Inverpolly	218700,908900		Yes			
Banchory	367600,798500	Yes	Yes		Yes	Yes
Bowbeat	328300,647300		Yes	Yes		
Auchencorth Moss	322000,656200	Yes	Yes		Yes	Yes

3.1.7 Acid Deposition Monitoring Networks

Measurements of a wide range of parameters and species are undertaken as part of the Acid Deposition Monitoring Network including – pH, SO_4, NO_3, NH_4, Na, Mg, Ca, Cl, K, PO_4, nss-SO_4, H and conductivity. There are 11 monitoring sites in Scotland as detailed in Table 3.8 below.

Table 3.8. Acid Deposition Monitoring sites in Scotland

Site Name	Grid Ref
Glensaugh	366029,779670
Eskdalemuir	323500,602800
Strathvaich Dam	234700,875000
Allt a' Mharcaidh	287500,803500
Whiteadder	366180,663130
Loch Dee	246630,578135
Polloch	179250,768950
Balquhidder 2	254550,720750
Loch Chon	242960,708370
Lochnagar	325400,786120
Forsinain	290395,948735

3.1.8 Ammonia and Nitric Acid Monitoring Networks

There are 26 ammonia sampling sites in Scotland, 4 of which are also nitric acid measurement points. These details are summarised in Table 3.9.

Table 3.9. Ammonia and Nitric Acid Monitoring Sites in Scotland

Name	Grid Ref	Ammonia	Nitric Acid
Shetland	450000,1140000	✓	
Halladale 1	289400,951400	✓	
Inverpolly	218700,908800	✓	
Strathvaich Dam	234800,875000	✓	✓
Ellon Ythan	394500,830400	✓	
Pitmedden	388300,827800	✓	
Lagganlia	885600,203700	✓	
Allt a Mharcaidh	289500,802400	✓	
Rum	140800,799250	✓	
Glensaugh	366400,779900	✓	✓
Gulabin Lodge	311000,770100	✓	
Glenshee Hotel	311100,769900	✓	
Glen Shee	311700,769300	✓	

Name	Grid Ref	Ammonia	Nitric Acid
Tummel	274400,761100	✓	
Rannoch	260300,753300	✓	
Loch Awe	196600,711500	✓	
Edinburgh-Johnston Terrace	325300,673400	✓	
Bush 2	324700,663800	✓	
Bush 1	324500,663500	✓	✓
Auchencorth Moss	322000,656200	✓	
Carradale	179800,537800	✓	
Auchincruive	237900,623400	✓	
Sourhope	386700,621800	✓	
Eskdalemuir	323500,602800	✓	✓
Coalburn	369300,578200	✓	
Dumfries	254600,565800	✓	

3.1.9 Summary of National Monitoring in Scotland

National air quality monitoring in Scotland is characterised by measurements of a very wide range of pollution species at a relatively small number of monitoring locations. The pollutant species monitored at one or more measurement sites includes:

- 4 inorganic gases (CO, NO_2, SO_2 and ozone)
- Particles PM_{10} and $PM_{2.5}$
- 26 organic compounds (including benzene and 1,3-butadiene)
- 34 PAH compounds
- 22 metallic species (both airborne and deposited)
- ammonia and nitric acid
- and a number on anion and cation species in rainwater.

All of the data collected in the national networks are highly quality assured. The majority of these data are available on the UK Air Quality Archive Database and are supplied to EU and EMEP Europe-wide databases as appropriate.

However, some of the more specialist data are only available in reports from the individual network contractors and/or on their own databases.

3.2 LOCAL AUTHORITY MONITORING IN SCOTLAND

As part of the Pilot Study for a Scottish Air Quality Database AEA contacted all 32 Local Authorities in Scotland. A structured questionnaire approach was used to determine information on the air quality monitoring undertaken by each Local Authority. This survey builds on the email questionnaire survey undertaken by the Scottish Executive in 2005. A summary of the information obtained is provided in Appendix 1. Monitoring undertaken by Local Authorities naturally focuses on the pollutants covered by the UK Air Quality Strategy – benzene, 1,3-butadiene, carbon monoxide, lead, nitrogen dioxide, particles (PM_{10}) and sulphur dioxide. Local Authorities have a statutory duty to undertake a Review and Assessment of these pollutants under the requirements of the Environment Act (1995). However, as virtually no Authorities have identified any problems with benzene, 1,3-butadiene, carbon monoxide, lead and very few with sulphur dioxide, the monitoring undertaken is primarily for nitrogen dioxide and PM_{10} particles.

3.2.1 Automatic monitoring in Local Authority Areas

Table 3.10 summarises the information for automatic air quality monitoring of NO_2, SO_2, CO, Ozone and particulate matter (PM_{10}) – for completeness, this table also includes national network sites for these pollutants. A total of 83 separate automatic monitoring locations were identified and the table shows the breakdown for each pollutant. The full list of monitoring sites and locations is provided in Appendix 1.

Table 3.10. Number of Air Monitoring Sites in Local Authority Areas (includes both National and Local Authority Sites)

Council	NOx	SO_2	CO	O_3	PM10 TEOM	PM10 BAM	PM10 grav-	PM10 Osiris
Aberdeen City	4	1	1	1	5	-	-	-
Aberdeenshire	-	-	-	-	-	-	-	-
Angus	1	1	1	-	1	-	3	-
Argyll and Bute	-	-	-	-	1	-	-	-
Clackmannanshire	-	-	-	-	1	-	-	-
Comairle nan Eilear Siar	-	-	-	-	-	-	-	-
Dumfries and Galloway	2	-	1	1	-	-	1	-
Dundee City	4	1	-	-	3	-	1	3
East Ayrshire	1	1	1	-	1	-	-	-
East Dumbartonshire	2	-	-	-	-	2	1	-
East Lothian	1	-	-	-	1	-	-	-
East Renfrewshire	1	-	-	-	1	-	-	-
City of Edinburgh	6	1	1	1	5	-	-	-
Falkirk	5	6	3	-	5	-	-	-
Fife	3	1	1	-	2	-	-	-
Glasgow City	7	3	5	2	7	-	-	-
Highland	2	-	1	2	-	-	1	-
Inverclyde[1]	0.5	-	0.5		0.5	-	-	-
Midlothian	2	2	-	2	2	-	1	-
Moray	-	-	-	-	-	-	-	-
North Ayrshire[1]	0.5	-	0.5	-	0.5	-	-	-
North Lanarkshire	6	2	1	-	6	-	1	-
Orkney	-	-	-	-	-	-	-	-
Perth and Kinross	2	-	-	-	2	-	-	-
Renfrewshire	3	-	-	-	1	-	1	-
Scottish Borders	-	-	-	-	-	-	-	-
Shetland	-	-	-	1	-	-	-	-
South Ayrshire	-	-	-	-	1	-	-	1
South Lanarkshire					1			
Stirling	1	-	-	-	1	-	-	1
West Dunbartonshire	2	-	-	-	-	-	-	-
West Lothian	1	1	1	-	2	-	-	-
Total	**57**	**20**	**18**	**10**	**50**	**2**	**10**	**5**

1 - one mobile monitoring station is shared between Inverclyde and North Ayrshire

3.2.2 Non-Automatic monitoring in Local Authority Areas

Monitoring of nitrogen dioxide with diffusion tube samplers is widely undertaken throughout the whole of Scotland. From the information supplied by the Councils, almost 850 monitoring sites are currently in operation (Table 3.11). Four Councils (East Ayrshire, Falkirk, Inverclyde and South Ayrshire) undertake monitoring of benzene and one Council (Falkirk) also undertakes monitoring of 1,3-butadiene with diffusive samplers.

Table 3.11. Non Automatic Monitoring undertaken by Local Authorities in Scotland

Council	NO_2 diffusion tube sites	Benzene	1,3-butadiene	SO_2 (indicative only)
Aberdeen City	30			
Aberdeenshire	15			
Angus	10			
Argyll and Bute	10			
Clackmannanshire	10			
Comairle nan Eilear Siar	4			
Dumfries and Galloway	11			
Dundee City	95			
East Ayrshire	10	10		
East Dumbartonshire	22			
East Lothian	18			
East Renfrewshire	21			
City of Edinburgh	60			
Falkirk	66	20	7	
Fife	34			4
Glasgow City	102			
Highland	14			
Inverclyde	16	3		
Midlothian	14			
Moray	13			
North Ayrshire	31			
North Lanarkshire	50			
Orkney	10			
Perth and Kinross	42			
Renfrewshire	40			
Scottish Borders	19			
Shetland	0			
South Ayrshire	20	2		
South Lanarkshire	14			
Stirling	25			
West Dunbartonshire	16			
West Lothian	6			
Total	**848**	**35**	**7**	**4**

3.2.3 Summary of monitoring undertaken by Local Authorities

Local Authority air quality monitoring in Scotland is characterised by measurements of a limited range of pollution species (primarily NO_2 and PM_{10}) but at much larger number of monitoring locations. In total, 83 automatic monitoring sites are used to measure one or more pollutant species (Appendix 1). The site numbers for the individual pollutants are summarised below

- NO_2 57
- SO_2 20
- CO 18
- PM_{10} 67

In addition, there are almost 850 diffusion tube monitoring sites for nitrogen dioxide.

Of the total of 83 automatic sites 14 are national network sites in the AURN, a further 19 are in the AEA Calibration Club. The remaining 50 sites are operated by the Local Authorities either by themselves or in collaboration with equipment suppliers or other consultants. In general, data for all of these sites have been used within the air quality Review and Assessment process and have been accepted by the Scottish Executive and SEPA as of appropriate quality for this purpose.

However, it should be noted that if these sites are to be included with the Scottish Air Quality Database then there will need to be some harmonisation of procedures and calibration standards across all sites to ensure that the data in the database are harmonised and fully representative for the whole of Scotland. In addition, as the data will be available on a daily basis to the public it is important that there is an efficient system to check data frequently and to respond quickly to any site problems or faults.

3.3 HARMONISATION OF SCOTTISH AIR QUALITY DATA

With regard to NO_2 diffusion tube samplers there has been a long history of National level harmonisation programmes to support Local Authorities in these measurements. Initially this was through the UK NO_2 Diffusion Tube Network, but is now provided as part of the Local Authority Support Project (http://www.laqmsupport.org.uk/).

National network automatic sites are subject to robust QA/QC procedures to ensure harmonisation of data throughout the UK. As it is planned for the Scottish Air Quality Database to include both National and Local Authority data for Scotland, we recommend that a programme of harmonisation will be required to ensure compatibility of the data. For the Air Quality Databases for Wales and for Northern Ireland harmonisation programmes are in place for all Local Authority automatic monitoring data that are included into these databases.

We suggest that a programme for Scotland should include:

- Independent audit of every site - to include checks on both the analysers and the site calibration cylinders
- Regular data checks
- Common site operational procedures, a site operation manual and suitable training, where required, for site operators
- Longer term data checking and adjustment where necessary.

Audits will ensure that analysers are working correctly and that on-site calibration gas standards are all referenced to a common standard, which itself is referenced to UK and international standards.

Data loaded onto the website in real time will, of course, be provisional data. However, these data will be available to the public so there is a need to ensure that the data are of reasonable quality, even at this stage. A vital tool for this is regular checking of the data by experienced personnel.

Correct calibration of the monitoring sites is a crucial function for ensuring high quality data. Where this is done automatically, the audits will help to identify that the calibration system is operating correctly. However, we still recommend that additional manual calibrations will be of considerable value.

Manual calibrations need to be undertaken correctly. The Local Site Operator Manual for the AURN provides comprehensive advice and instructions for calibration of a wide range of analyser types. The LSO Manual is available at http://www.aeat.co.uk/netcen/airqual/reports/lsoman/lsoman.html .
We recommend that Local Authorities follow the general principles of calibration given in the manual where this is appropriate. However, it should be noted that this manual is designed specifically for national network site configurations and

may not be appropriate for all Local Authority equipment or station configurations.

Data checking and review is the process of assessing and accepting data or, if necessary, adjusting or deleting data to produce a final corrected dataset upon which all subsequent analysis can be undertake – for example calculation of annual statistics to show compliance with air quality standards and objectives.

With a system of procedures in place to ensure harmonisation of data throughout Scotland, users of the Scottish Air Quality Database website will be able to use data with confidence to make reliable comparisons of air pollutant concentrations throughout Scotland.

3.4 RECOMMENDATION

There is considerable monitoring of air pollution undertaken throughout Scotland. Within the national networks over 90 pollutant species are monitored, but at a relatively small number of monitoring sites. Monitoring undertaken by Local Authorities is much more extensive in terms of geographical coverage and site numbers (83 automatic sites and over 800 diffusion tube monitoring sites). However, it is restricted to a much more limited set of pollutants – primarily those covered by the UK Air Quality Strategy.

The proposed Scottish Air Quality Database seems to be an ideal mechanism to bring all of these datasets together into one database which will readily be accessible to the public, Local and National Government, research bodies and regulatory bodies such as SEPA. However, to ensure that the data are fully harmonised across Scotland there is a requirement for some harmonisation of calibration standards and site operating procedures across all monitoring sites.

4 Web Logger Trial

4.1 INTRODUCTION

For the pilot study project we have worked closely with Air Monitors Ltd to evaluate the operation of the new Web Loggers in parallel with AEA's existing data acquisition systems at six monitoring stations. It was recognised that by running systems in parallel the full benefit of the Web Logger technology may not be available in all cases, but never-the-less it was felt important to run the trials under these conditions at least at some of the sites. The full schedule of work for Air Monitors part of the project was as follows:

- Provision of six Web Loggers for which the project will take ownership.
- Provision of six Sim cards for GPRS communications on VPN with fixed IP addresses, including communication costs, VPN and data server management.
- Site inspection and pre-installation survey.
- Provision and development of data file generator compatible with AEA data upload requirements for the Pilot Study Scottish Air Quality Database.
- Installation of Web Loggers at each site.
- Management of communication system throughout the project.

- Service and support of Web Logger hardware throughout the project.

The Web Logger package offers a new generation of technology to air monitoring systems, whereby results from monitoring sites are available instantaneously at any time of the day of night over a direct (3G, GPRS or broadband) internet connection. The Web Logger can enable two-way communication between an office based PC and a wide range of different brands of air pollution analysers in the field. Calibrations and diagnostics can also be carried out remotely whilst based in the office if required. Full technical details of the Web Logger are provided in Appendix 2 of this report.

4.2 SITE SELECTION

At the outset of the project, in January 2006, AEA and Air Monitors met to discuss the types of monitoring sites which should be selected for the pilot study. It was agreed that if possible we would select:

- Sites with a range of different analyser types.
- A good geographical range of locations across Scotland.
- A range of national network and Local Authority sites.
- Some sites where the existing and new technology could be run in parallel, but;
- Where the Web Logger would not cause any interference with existing data management systems.

However, in all cases the agreement of each Local Authority and any other interested parties would need to be sought before installation could commence. It was agreed that the introductory seminar for the project would be the best place to announce the plans and to seek volunteers willing to participate in the free trial.

Following the seminar on March 30th Air Monitors received a total of eleven Local Authority volunteers for the pilot study (see Table 4.1 below).

Table 4.1 – List of Local Authority volunteers for Weblogger trial

Local Authority	Site Name	Type
Edinburgh	Several	Various
Dundee	Scientific Services	Urban Background
S Ayrshire	Prestwick	Various
Fife	Cupar	Kerbside
Clackmannanshire	NA	NA
West Lothian	Linlithgow	Urban Background
West Lothian	Whitburn	Urban Background
West Dumbarton	Balloch	Roadside
Falkirk	Several	Various
Glasgow	Several	Various
Aberdeen	Several	Various

This list needed to be reduced to six monitoring stations. To achieve this Air Monitors visited a selection of sites to identify which would be the most suitable, resulting in the final choice of the following in Table 4.2 overleaf.

Table 4.2 – Final list of monitoring sites selected for trial

SITE	TEOM	NO_X	CO	SO_2	Ozone
Fife Cupar	✓	✓	-	-	-
Dundee Mains Loan	✓	-	-	-	-
Edinburgh Roseburn	✓	✓	-	-	-
Glasgow Byers Road	✓	✓	✓	-	-
Whitburn	✓	-	-	-	-
Aberdeen Union St.	✓	✓	-	-	-

Air Monitors carried out installation of the equipment in April and May 2006 so that a six month period of operation was achieved before completion of the project on October 31st 2006.

4.3 DATA PROVISION

Data from the Web loggers were provided to the pilot study Scottish Air Quality Database via an automatic data feed over the internet from Air Monitors to AEA. AEA worked with Air Monitors to develop the format and method for this file transfer as part of the project. Two methods of data transfer were successfully developed, initially by e-mail and then by automatic ftp file transfer.

This development will benefit any Local Authorities who use the Web loggers in the future and may wish to contribute data to a Scottish Air Quality Database.

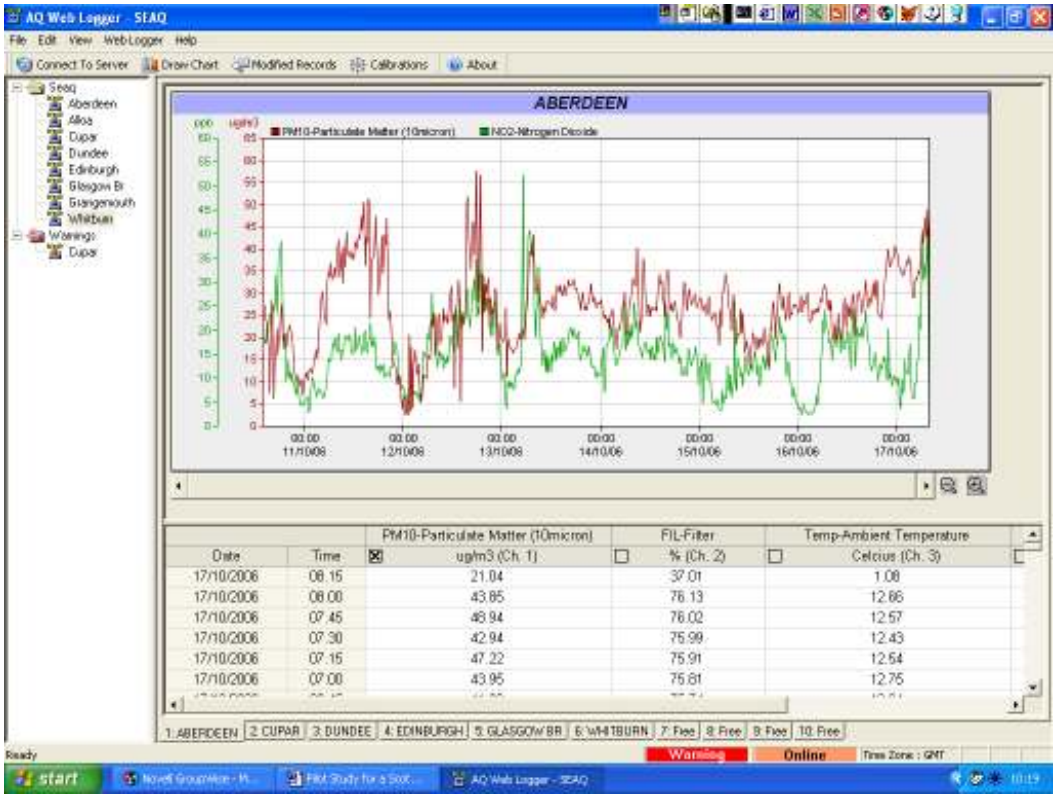
Air Monitors also provided AEA and each of the Local Authorities involved in the trial with a copy of the Web Logger software for direct access to the site data, analysis tools, diagnostics and calibration control. There were some initial IT issues experienced by both AEA and Local Authorities with opening the required internet port in order to get the software to operate. This should not have been a particularly difficult task, but both AEA and many of the Local Authorities had to go through an IT service provider to open the port. The problem was therefore mainly one of communication, and in some cases the providers taking an opportunistic approach to charge their customers for a relatively simple task.

Once the port was opened then the software was found to be intuitive and user-friendly, giving easy access to graphs and data from the monitoring sites, as illustrated in Figure 4.3 overleaf.

Throughout the course of the trial the data flow was successfully maintained with minimum downtime. There was only one instance where Air Monitors moved the service from their trial server to a more permanent system, and due to a configuration error up to 48 hours data were lost at two sites.

At a number of meetings the facility to carry out remote calibrations was demonstrated live over the internet by Air Monitors using the Web Logger software and the NO_x monitor at the Fife Cupar monitoring station. The calibrations were seen to be extremely stable and easily managed using this facility.

Figure 4.1 – Web Logger Data Management Software



4.4 ISSUES IDENTIFIED DURING THE TRIAL

Other than the IT issues with the Web Logger software mentioned earlier, the project generally went very smoothly. However, there were a number of lessons learned and issues raised by AEA and Air Monitors which primarily resulted from the need to run the web loggers in parallel with the existing logging systems:

- Some calibration data were not flagged because the calibration system was being operated by the parallel logging system rather than the web logger
- Calibration results were not always available for reason stated above.
- Some small differences were found between the analogue (old system) and digital (Weblogger) data being reported.

AEA were assured that these issues would not be present in a monitoring station where the Weblogger had full functional control over all the analysers.

At the end of the project the six Web Loggers will remain the property of the Scottish Executive. However, of course, for them to continue to function payment for SIM card provision, and data server will be required in the same way that payment for phone calls is required for other logging systems. However the overall costs with the Weblogger are typically less for hourly data collection from multi-instrument monitoring stations.

5 Stakeholder Interaction

One of the key objectives of the project was to:

- Liase with stakeholders and gain their views on requirements of a database. This should include Local Authorities, SEPA, and environmental health bodies in Scotland.

To deliver this aspect of the work the following activities were undertaken:

- A presentation to the Scottish Natural Environment Statistics Advisory Committee (NESAC).
- An introductory seminar at the outset of the project, held in Edinburgh.
- A meeting with SEPA and Scottish Executive staff to present and discuss the first beta version of the pilot study web site and database.
- On-line questionnaire and feedback on the pilot-study web site.
- Closing project seminar to present the work and review feedback.

These are described in further detail below.

5.1 NESAC MEETING ON MARCH 29TH.

Paul Willis presented at this meeting held at Victoria Quay and attended by around 20 experts in statistical analysis of environmental data. The agenda for the meeting is presented in Box 5.1 overleaf to illustrate the range of topics discussed at this forum. The objective was to introduce the rationale behind the project, and to detail the work to be carried out under the various tasks. Generally the committee members were very supportive of the project, and asked to be kept informed of how the project progressed and it's outputs.

The following NESAC members were invited to the meeting:

SEPA
SCIEH
SNH
CBI Scotland
RSS
SEPA
SE Environment Statistics
SE Environment Research
SE DD Senior Statistician
SE Public Health
SE Ecological Advisor
SE Strategic Environmental Assessment Team
SE Environment and Social Research
SE Sustainable Development Strategy Team
SPICe
MLURI
SE Environment Economics
FRS
Forestry Commission
Soc. Of Chief Officers of Env. Health

Box 5.1 – Agenda for NESAC Meeting 29th March 2006

10th Meeting of the
NATURAL ENVIRONMENT STATISTICS ADVISORY COMMITTEE
Wednesday 29th March 2006 at 11:00am in Conference Room 3, Victoria Quay

Agenda

Morning Session

Presentation: "The Benefits of Local Environmental Quality Monitoring" by Donna Niven (Keep Scotland Beautiful)

Presentation: Pilot Scottish Air Quality Database by Paul Willis

Afternoon Session

1. Minutes of last meeting (NESAC (06) 02)
2. Matters arising
3. Sustainable Development Indicators update - Helen Mansbridge (SE)
4. The European Environment State and Outlook 2005 – Ed Mackay (SNH) (NESAC (06) 03)
5. Scottish Environment Statistics Availability – report on gaps in the provision of statistics by policy drivers (NESAC (06) 04)
6. Scottish Executive Publications: Key Scottish Environment Statistics 2006/ Scottish Environment Statistics Online (NESAC (06) 05)
7. Recent and Forthcoming Publications / Outputs and Developments (NESAC (06) 06)
8. ScotStat business (NESAC (06) 07)
    a. Issues raised by the ScotStat Board
        i. *DRAFT NESAC workplan 2006/2007.*
        ii. *DRAFT SE Statistics Plan 2006/2007 – Environment.*
    b. NESAC representation on the ScotStat Board required
9. Any other business
10. Date of next meeting

Scottish Executive
March 2006

5.2 INTRODUCTORY SEMINAR 30TH MARCH.

An introductory seminar for the Scottish Air Quality Database and Web Site Pilot Study was held in Edinburgh on Thursday March 30th 2006. The event was attended by over forty air quality experts from a range of Local Authorities and other stakeholder groups in Scotland. The objective was to introduce the project and to gain feedback on the proposed work programme and web site content.

Feedback from the delegates was extremely positive, especially from Local Authorities who considered that a central, reliable Scottish resource for air quality data would be extremely useful.

The agenda for the day is presented below in Box 5.2. Following the meeting the presentations were loaded to the password protected http://www.scottishairquality.co.uk/ web page.

Box 5.2 – Agenda for Introductory Seminar 30th March 2006

Scottish Pilot Study Air Quality Archive and Web Site
- Introductory Seminar

Date Thursday March 30th 2006

Time 10.30

Location COSLA Building, Edinburgh

PROGRAMME

Chair – Ken Stevenson, Netcen

1. 10.30	Coffee and Registration	
2. 11.00 - 11.15	Welcome and Introduction to the Project	Geeta Wonnacott (SE)
3. 11.15 – 11.30	Update on the Review of the Air Quality Strategy	Andrew Taylor (SE)
4. 11.30 – 12.00	AQ Web Sites and Information Dissemination	Jon Bower (Netcen)
5. 12.00 – 12.15	Feedback and Q&A Session	
LUNCH 12.15 – 13.15		*Internet Access should be available for viewing other AQ Web Sites*
5. 13.15 - 13.45	AQ Monitoring in Scotland and QA/QC.	Ken Stevenson (Netcen)
6. 13.45 – 14.15	Use of Web Logger technology in the project.	Jim Mills (Air Monitors)
7. 14.15 – 14.45	AQ trends analysis and mapping for Scotland	Paul Willis (Netcen)
8. 14.45 – 15.00	Further Feedback and Q&A	
CLOSE 15.00		

5.3 MEETING WITH SEPA AND SCOTTISH EXEC.

On July 18th 2006 Paul Willis attended a meeting at the Scottish Executive to present the first beta version of the web site and database. The following SEPA and Scottish Executive staff attended the meeting:

Geeta Wonnacott – ERAD
Antje Branding – ERAD
John Landrock – SAG
John Lamb – SEPA
Bob Boyce – SEPA
Jane Allen – SEPA
Anna Douglas – SEPA

The web site and database were successfully demonstrated live on-line. A useful discussion ensued and a number of suggestions for immediate and future imporvements to the system were agreed. These are listed in Box 5.3 below. Many of the ideas (highlighted in grey) were incorporated into the final version of the pilot study database and web site. The other comments were noted for future development work.

Box 5.3 – Agreed Recommendations from SEPA/Scottish Exec. Meeting on July 18th 2006.

- Remove regional boundaries on map of Scotland
- Add a facility to view one pollutant at a time
- Clarify units of measurements i.e. annual, daily means etc.
- Insert unit for altitude
- Insert link to UK archive for AURN sites and the national forecast web page
- Display results as low, medium, high and very high rather than numbers and provide a legend
- Insert some general text on air quality in Scotland i.e. compared to rest of UK and why we have lower limits for PM/Benzene
- Explain why certain pollutants are omitted i.e. too few sites
- Have a specific button in menu to view maps
- Have a specific button in menu to view trends
- Provide a link to APIS in the trends front page
- Rename map as LAs with AQMAs and provide a brief explanation - make explicit that not the whole authority is designated but specific parts. Add a zoom facility to maps. Provide a list of LAs which have AQMAs
- Contact Ian Henton (EHS3) to discuss LA responses re: monitoring
- Make some reference to long-range trans-boundary air pollution
- Make some mention early on re: high number of sensitive (to air pollution) ecosystems in Scotland

5.4 ON-LINE QUESTIONNAIRE AND FEEDBACK

In addition to the various stakeholder meetings and seminars it was agreed that once the pilot-study web site and database was completed, a questionnaire would be placed on-line to gather feedback from the users who had tested it. The questionnaire was designed so that once the fields were completed the response e-mailed directly back to the AEA staff for compilation and analysis. The questionnaire gathered feedback in six areas:

- Look and Feel of Site
- Navigation and Access
- Relevance
- Availability of Data
- Availability of Reports
- Any Other Comments

The following organisations provided feedback through the questionnaire:

Scottish Executive
Health Protection Scotland (NHS)
West Lothian
Dundee
SEPA
North Lanarkshire
Glasgow
East Renfrewshire
Dumfries and Galloway
Aberdeen
Midlothian

Results were as follows (comments highlighted in grey have already been addressed):

Question 1 – Look and Feel of Site

Web-site looks fine
Generally a good and well presented site
Good - mountains are particularly pleasing
The site looks professional and is well thought out, with some similarities to the national air quality archive website.
The site looks and feels very professional and is easy to read.
Good
Easy to view and not over complicated.
Excellent comparing site to site and info provided can only improve with use
Clear, uncluttered, good.
Excellent. Clearly laid out.

Question 2 – Navigation and Access

Easy to use and access
On the Home Page there are 5 colours on the map, but only 4 links to air pollution forecasts.
Good. Accessibility
The site is relatively easy to navigate using the menu options at the top and the side of the web pages. The site search function is also useful if you cannot find what you are looking for.
Easy to navigate.
No difficulty encountered in navigating site. Easy to locate local data and compare with other sites in Scotland.
Good, although I initially found it perplexing probably me.
It would be helpful if the map showing the monitoring stations across Scotland were larger due to the number of overlapping locations.   Dropdown menus from the tabs at the top of the page would be useful e.g. Tab: About Air Quality Dropdown menu: Pollutants, Impact, Monitoring, Policy, Standards In terms of disability accessibility an option to view in larger text may be helpful.
Navigation & accessibility OK
Very easy to use.

Question 3 – Relevance

All information seemed to be relevant
Good
On the home page on 22 September the air pollution in Scotland is "moderate", but actually only a station has a moderate pollution.
Spot on
Information presented is comprehensive and I would think that everyone from professionals to members of the public should be able to find material that is relevant to them and of interest.
I feel that the information provided is appropriate and will be of use to both the public and local authorities.
Useful for public and local authorities and consultants in the field of air quality. Particularly useful if have a local issue e.g. a pollution incident and want to compare with other authorities. Wording not too technical and therefore should be understood by the public with limited knowledge of air quality issues.
Very relevant in general terms. The sites nearest to Midlothian do not give the most helpful of info but I can see the site being of real value to consultants and the scot. exec.
Excellent
The information is very relevant for research into many illnesses caused by air pollutants.

Question 4 – Availability of Data

Some data was missing for our site.
Handy to see the locations of stations. Data about stations are OK.
Great.
Data is relatively easy to access and is in-line with that on the national air quality archive website.
Good but scope for more.
Obviously the data availability depends on local authorities doing the monitoring and being able to provide the data in a usable form. I feel that the site provides a good range of data.
Notice lack of updated information for Aberdeen Union Street and Anderson Drive - will need to liaise with aeat to check links.
If the site could be augmented to include even more sites it might prove even more valuable.
Although the website says the data comes from "sophisticated" air quality monitoring stations across Scotland - maybe for the uninitiated the fact that the data is \"provisional\" should be highlighted and an explanation for this be included in the "glossary of terms". It would be helpful to know whether the Particulate data presented is gravimetric/Teom/Bam/or adjusted in any way.
Whilst the availability of data is limited at the moment I presume historical data will be added when possible.

Question 5 – Availability of Reports

Most reports were available
OK Maps showing air quality in Scotland show some odd results : maps 12, 13, 14 have large square areas.
Good
Once the website is fully operational and available to the public, more reports should be made available, e.g. local authority review & assessment reports.
Could be a lot more.
No comment.
Good
Not checked
No comment.

Question 6 – Any Other Comments

In view of the instances of trans-boundary pollution episodes (especially PM_{10}) I was wondering if met. data, e.g. wind speed/direction data from those monitoring stations with anemometers could also be made available on the website.
Site graphs - the lines that have markers make it difficult to see. Would be useful to have the option to deselect markers.
My main comment about this page is the table relating to the different air pollutants and their objectives. A lot of attention is paid to the National AQS. This website is aimed at primarily a Scottish audience, therefore would it not be better to revise the table showing the Scottish objectives only as it\'s difficult to pick these out without reading about England, Wales & NI. A link to the National AQS could then be added for anyone who has a wider interest. The Air Quality Standards page is very cluttered and the traffic light colours used to explain the different pollutants and their health impacts & severity may not suit all viewers, although I understand the choice. A spell check throughout the website may also be worthwhile e.g. Deumfries (they might not be best pleased!!)
Data graphs could be better presented and it can be difficult to see information clearly. It is difficult to click on individual sites on the 'air pollution in Scotland' map to see further information. All in all, the website is great concept and will help to bring air quality in Scotland to a wider audience and hopefully raise the profile of air quality generally in Scotland. It is also an opportunity for more consistency in the collection and presentation of data from Scottish local authorities.
Re the air quality standards pages I think there should be a note that the Air Quality Limit Values (Scotland) Regulations 2001 and the Air Quality Limit Values(Scotland) Amendment Regulations 2002 were revoked by the Air Quality Limit Values (Scotland) Regulations 2003. These 2003 Regulations were amended in 2003 & 2005 not 1005. The PM_{10} objective of 18 micrograms per cubic metre is to be achieved by 2010 not 2004 and applies to Scotland only so far as I am aware.
There is a lack of co-ordinated air quality information across Scotland and therefore the site is much welcomed. It would be helpful if links were provided to local authority websites to provide information on any local developments and other data.
Is it possible to include a further comment on the Excel spreadsheet that an LSO in Midlothian does attend the site on a fortnightly basis and does carry out calibration checks. If the 14 monitoring PDT s can be included at a future date will it include the co-location details of the tri tube location and the Dalkeith real time monitor? Info available for Midlothian is under the 'Bush Estate' this is very much a rural idyll and bears no real relation to suburban conditions which pertain generally in Midlothian Info on NO_x SO_x and PM_{10} is available separately for the town of Dalkeith as well info on PM10 and SO2 at the village of Pathhead (domestic fuel primarily solid fuel).
I've had a quick glance through and was wondering whether for monitoring stations with more than one pollutant (e.g. Aberdeen/ Edinburgh! St Leonards) it would be possible to have 2y (or multiple) axis graphs so that it's easier to distinguish the different pollutant levels. In respect of Dundee there are some inaccuracies* in the information reported and it is not clear what protocol is available for having these amended/updated. *An AQMA for NO2 (annual mean) has been declared. As Dundee has a number of smoke control areas that together practically cover the whole geographic extent of the authority we feel that the wording "Parts of this Local Authority may be declared as a Smoke Control Area" is not sufficiently emphatic. We note however that we don\'t strictly fall into the alternate category "The whole of this Local Authority is a Smoke Control Area" -indeed no LA in Scotland appears to, and it is unlikely that this situation would change - making that option essentially redundant. Maybe a change to the categories would be an idea - at least a change to the second one so that it reads "Parts of this Local Authority are declared as Smoke Control Areas" would be better.
Generally impressed with the site.
Provides a good resource for obtaining air quality data across Scotland. As more data and monitors are added this can only get better.

Where specific inaccuracies were identified these were immediately addressed and have been highlighted in the tables above. The remaining comments were collated for discussion at the final seminar and to hopefully assist with development of the full public version of the database and web site at some point in the future.

5.5 FINAL PROJECT SEMINAR 11TH OCTOBER

The final seminar for the Scottish Air Quality Database and Web Site Pilot Study was held in Stirling on Wednesday October 11th 2006. The event was attended by almost forty air quality experts from a range of Local Authorities and other stakeholder groups in Scotland. The objective was to present the work carried during the pilot study, review the feedback received via the web site, and to discuss options for improving what had been done so far.

Feedback from the delegates was once again extremely positive, with much enthusiasm for developing the project into a long-term resource.

The agenda for the day is presented below in Box 5.5. Following the meeting the presentations were loaded to the password protected http://www.scottishairquality.co.uk/ web page.

Box 5.5 – Agenda for Final Seminar 11th October 2006

Pilot Study for a Scottish Air Quality Database and Web Site - Final Stakeholder Seminar

Date Wednesday 11 October 2006

Time 10.30

Location Municipal Building, Council Chambers, Stirling

PROGRAMME

Chair – Ken Stevenson, Netcen

1. 10.30	Coffee and Registration	
2. 11.00 - 11.15	Welcome and Introduction to the Project	Geeta Wonnacott (SE)
3. 11.15 – 11.45	Air Quality in Scotland – pilot database and website	Paul Willis (Netcen)
4. 11.45 – 12.15	Feedback and Q&A Session	

LUNCH 12.15 – 13.15

5. 13.15 - 13.40	AQ Monitoring in Scotland and QA/QC.	Ken Stevenson (Netcen)
6. 13.40 – 14.05	Use of Web Logger technology in the project.	Jim Mills (Air Monitors)
7. 14.05 – 14.30	AQ trends analysis and mapping for Scotland	Keith Vincent (Netcen)
8. 14.30 – 15.15	Questions and general discussion on requirements for future development of the database.	

CLOSE 15.15

6 Air Quality Mapping for Scotland

6.1 INTRODUCTION

A pilot mapping exercise has been undertaken on behalf of the Scottish Executive to provide a comparison of the results of a national air quality modelling method in 2004 with results from Scottish air quality monitoring data and to examine possible improvements to the model in representing Scottish concentrations.

Each year AEA performs detailed modelling exercises on behalf of Defra and the Devolved Administrations (DAs) to produce up-to-date maps and projections for the future (2010, 2015 and 2020) in order to supplement data from the national monitoring networks to satisfy the UK's Daughter Directive reporting requirements. The outputs are maps of background air pollutant concentrations on a 1 x 1 km grid and roadside air pollutant concentrations for urban road links. The models are calibrated using data from the national networks (chiefly the Automatic Urban and Rural Network, AURN) and are verified using independent monitoring data from Local Authorities and ad-hoc monitoring campaigns that have been quality assured to the same standard as the AURN. Because the modelling employs a single set of calibration coefficients to represent the whole of the UK, there are some regions that might be better represented by a more specific calibration relationship. Scotland, as a result of its wide rural expanses, is such a region that may not conform as well as other areas to the general calibration performed for the UK as a whole.

The exercise consists of two parts:

- **Task 1** – an assessment of the model performance against Scottish air quality monitoring data
- **Task 2** – attempting to improve the model by tailoring components to Scotland.

Task 1 is a detailed examination of the national model's current performance for Scotland in 2004. This includes plotting the model results against Scottish monitoring data as verification charts. Associated tables summarising this verification are also provided and include the average modelled values, average measured values, coefficient of variation (R^2), the number of sites used and the percentage of these that fall within the EC data quality objectives for modelled data for each pollutant. The national output maps (1 x 1 km background maps and roadside maps for urban road links) are presented for Scotland.

Task 2 has attempted to improve the model results by tailoring model components to Scotland. This has involved remodelling of several pollutants (deemed appropriate for improvement for Scotland) and an assessment of these results to examine the degree to which the model represents the monitoring data. The two methods of model improvement that were been identified were:

- Use of Scottish meteorological data – the ADMS modelling was performed using meteorological data from Edinburgh Airport. A new dispersion kernel was derived using these met data.

- Calibration of the model using only monitoring data from Scottish monitoring sites.

The pollutants examined in this analysis are limited to those pollutants and metrics covered by the EU air quality Directives and UK Air Quality Strategy that are routinely mapped by AEA on behalf of Defra and the DAs. A further restriction on the pollutants and metrics examined here are the presence of adequate monitoring in Scotland to allow the analysis. The period under examination, 2004, was selected as the most recent year for which AEA's national scale models had been developed. This meant that monitoring data from Scotland were limited to relatively few sites and as a result ozone, benzene, 1,3 butadiene or $PM_{2.5}$ are not presented. Table 6.1, presents a summary of the national network sites that were used in the recalibration and verification of the national models for Scotland.

The pollutants and metrics routinely mapped for Defra and the DAs and covered by this analysis include:

- CO annual average concentration (mg m^{-3})
- CO maximum 8 hourly concentration (mg m^{-3})
- NO_x annual mean concentration (μg m^{-3})
- NO_2 annual mean concentration (μg m^{-3})
- PM_{10} (TEOM) annual mean concentration (μg m^{-3})
- PM_{10} (gravimetric) annual mean concentration (μg m^{-3})
- SO_2 annual mean concentration (μg m^{-3})
- SO_2 99.9th percentile of 15 minute means (μg m^{-3})
- SO_2 99.73rd percentile of hourly means (μg m^{-3})
- SO_2 99.18th percentile of daily means (μg m^{-3})

The particulate matter modelling has been performed in both TEOM and gravimetric units. Gravimetric mapping was performed using Partisol data from the national networks, other PM_{10} instruments were omitted.

The small number of Scottish sites measuring some pollutants made it very hard to achieve a meaningful verification of the model performance and was a significant limitation on the recalibration of the models for Scotland. It should be noted that due to the limited availability of monitoring data in 2004, all of the sites used in the verification of the models were also used in the calibration of the national models and so do not provide an independent quality check. Also in Task 2 it should be noted that there were cases where an inadequate number of monitoring sites were available to make a recalibration of the model possible. This was the case for background and roadside gravimetric PM_{10} models and the roadside TEOM PM_{10} model. However, the methodology developed will allow the incorporation of additional monitoring data (of appropriate data quality) as these become available.

Here we will provide an overview of the methodology used in this comparison and summarise the results. The full set of analyses are published in a separate report *(Pilot Study Scottish Air Quality Mapping Exercise, Andrew Kent, AEA Energy and Environment, September 2006).*

It is not the intention here to document the complete methodology of the modelling process – this can be found in Stedman et al (2006). This report focuses on changes made to the models to improve the results for Scotland.

6.2 METHODOLOGY

The modelled maps are calculated from National Atmospheric Emissions Inventory (NAEI) data using a dispersion modelling approach which is calibrated using monitored data from the national networks (AURN). Each of the Scottish monitoring stations used in this analysis is in the national networks and this fully ratified and quality assured data have been included in the calibration relationship used in the national modelling. The modelled maps are then verified against independent monitoring data held by AEA (Local Authority sites within the AEA 'Calibration Club', ad-hoc monitoring campaigns run by AEA and other publicly available data from networks). Complete versions of these maps or the whole of the UK and detailed explanations of the modelling methodology and verification are presented in Stedman et al (2006).

The locations of each of the Scottish air quality monitoring sites were plotted with GIS on the modelled pollution maps and the corresponding modelled background concentration for the relevant 1 x 1 km grid square extracted. A 75% data capture threshold was applied to the monitoring data for this analysis - any site with data capture below this was omitted. At roadside sites, the corresponding modelled road link (where available) was used to ascertain a modelled roadside value rather than the modelled background concentration.

SO_2 is not modelled at roadside locations because roadside values are not significantly different from background values. As a result, modelled background concentrations were used for comparison with the monitored data at roadside sites instead.

The modelled information was directly compared with the corresponding monitored metric from each site and plotted in a scatterplot. The scatterplots are presented with tabulated statistics including the number of sites included in the analysis for each metric, the R^2 of the relationship between monitored and modelled data, the average of the modelled and monitored data for all sites and the number of sites within the data quality objectives. The analysis was performed separately for background (non-roadside) and roadside sites.

Examples of the Scottish air quality maps resulting from this pilot study are illustrated in Figure 6.1 below. For the complete set of results please refer to the separate report *(Pilot Study Scottish Air Quality Mapping Exercise, Andrew Kent, AEA Energy and Environment, September 2006).*

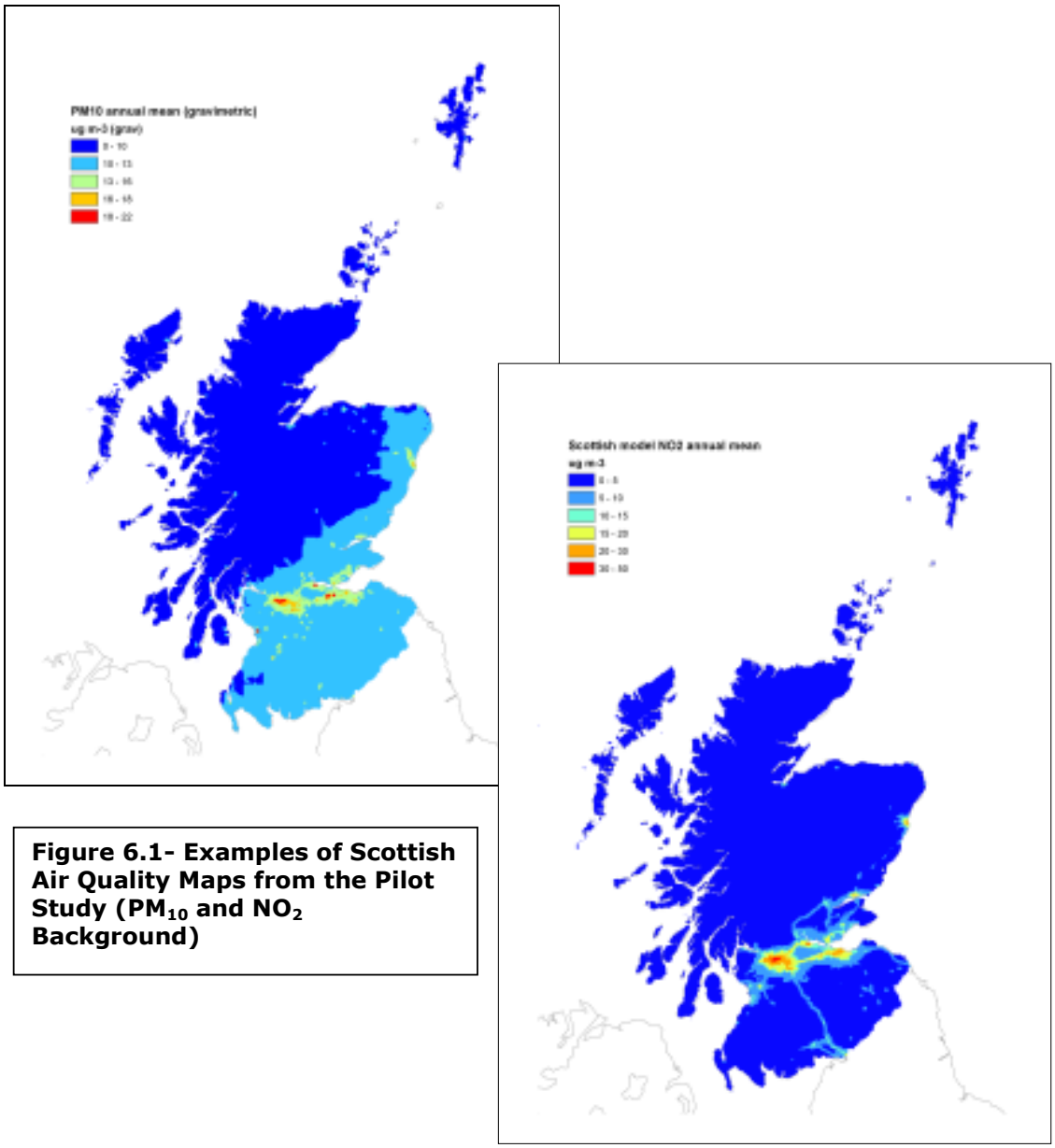


Figure 6.1- Examples of Scottish Air Quality Maps from the Pilot Study (PM_{10} and NO_2 Background)

All the monitoring sites included in this analysis are part of the AURN and have therefore been included in the calibration of the national model and examined in the UK scale study. Comparing the national model results for Scotland with data already used in the calibration offers no fully independent check but simply serves to illustrate the extent to which the model represents a single particular region.

A Scottish dispersion kernel was used to model all area sources in this work. This kernel was created in ADMS using Edinburgh Airport meteorological data for 2004. This provided a grid representing the proportional contribution of the central square to each surrounding squares. The matrix was then inverted to represent the contribution from the surrounding squares to the central square. This was the completed dispersion kernel.

The 2004 data from the national network sites have been fully ratified by AEA.

Table 6.1 Complete list of Scottish sites used in analysis

Site name	Easting	Northing	Site type	NO_x/NO_2	O_3	CO	PM_{10}	SO_2	Hydrocarbons *
Bush Estate	324626	663880	RURAL	✓	✓				
Eskdalemuir	323500	602800	RURAL	✓	✓				
Glasgow City Chambers	259528	665308	URBAN BACKGROUND	✓		✓			
Strath Vaich	234829	874785	REMOTE	✓	✓			✓	
Glasgow Centre	258902	665028	URBAN CENTRE	✓	✓	✓	†	✓	
Aberdeen	394416	807408	URBAN BACKGROUND	✓	✓	✓	†	✓	
Grangemouth	293840	681032	URBAN INDUSTRIAL	✓		✓	†	✓	
Edinburgh St Leonards	326250	673132	URBAN BACKGROUND	✓	✓	✓	†	✓	
Glasgow Kerbside	258708	665200	KERBSIDE	✓		✓	†		✓
Dumfries	297012	576278	ROADSIDE	✓		✓	‡		
Inverness	265720	845680	ROADSIDE	✓		✓	‡		

* Benzene and 1,3 Butadiene
† TEOM instrument
‡ Gravimetric Instrument

6.3 SUMMARY OF RESULTS

Please refer to the separate report for the complete set of results. The findings can be summarised as follows:

- The Scottish model demonstrated an improvement over the national model in annual mean and maximum 8-hour CO concentrations - the improvement in the maximum 8-hour metric was due to a large extent to the annual mean to maximum 8-hour relationship.

- The Scottish model results for NO_2 and NO_x were quite similar to the results provided by the national model but the Scottish model displays a marginally better fit about the 1:1 line – the result of the calibration based on these sites.

- The Scottish and national models were very similar in terms of the TEOM PM_{10} outputs. This feature is not surprising given the identical treatment of the secondary components in both models.

- For the year 2004, there is not really enough monitoring data to perform a robust calibration or to perform a fully independent verification of the Scottish model. However, the methodology has been developed through this project to facilitate incorporation of more Scottish air quality data sites (with appropriate data quality) as these become available. However, to make a significant improvement perhaps twice as many monitoring sites are likely to be required.

- The exception to this is SO_2 where there are more monitoring sites to use as a result of the incorporation of rural automatic monitoring data courtesy of the electricity generating industry and where the Scotland specific meteorological data appears to have yielded the largest improvement.

7 Air Quality Trends for Scotland

For many years it has not been possible to determine a robust trend in air quality for Scotland from the automatic monitoring data, due to the small number of sites available in the National Networks. One of the tasks in this project was therefore to revisit the trends analysis taking into account the additional Local Authority monitoring data which may become available through the development of the Pilot Study web site and database.

Two different trends analyses have been carried out:

- The average number of days per year with moderate or worse air quality in Scotland, known in the UK as the Headline Air Quality Indicator.
- Trends in the annual average nitrogen dioxide and PM_{10} (gravimetric equivalent) concentrations for urban background and roadside/kerbside locations across Scotland.

7.1 HEADLINE AIR QUALITY INDICATOR FOR SCOTLAND

AEA calculates the Headline Air Quality Indicators for the UK on behalf of Defra and the Devolved Administrations three times per year:

- In October, giving an idea of how summer pollution compares to previous years.
- In January, providing the provisional calendar year indicators.
- In April, reporting the final indicators based on the previous years' ratified data.

For this work we have developed a suite of sophisticated software which enables all the statistics to be calculated overnight taking into account a number of rules about data capture, parameters measured at each site and so on. There is also the facility to exclude from the trend some locations where there is known interference from local effects such as road maintenance or construction.

For this Scottish study the number of additional monitoring sites available in Scotland, which fully met the headline Air Quality Indicator criteria, was in fact limited to only an additional two in 2005, Glasgow Byers Road (Roadside) and Glasgow Waulkmillglen Reservoir (Rural). This is because the criteria state that for urban background locations ozone should be measured for sites contributing to the indicators, thus ruling out most Local Authority monitoring sites. For roadside or kerbside locations both NO_2 and PM_{10} are required, but in 2005 there was only Glasgow Byers Road which met both this criteria and the 75% data capture requirement.

Figure 7.1 overleaf presents the Headline Air Quality Indicator graph calculated from all the compliant Scottish data currently available in the pilot study database. It appears to show that there are no obvious trends upwards or downwards in the number of pollution episodes recorded in Scotland. However, this has to be considered in the context of the number of monitoring stations available for the analysis.

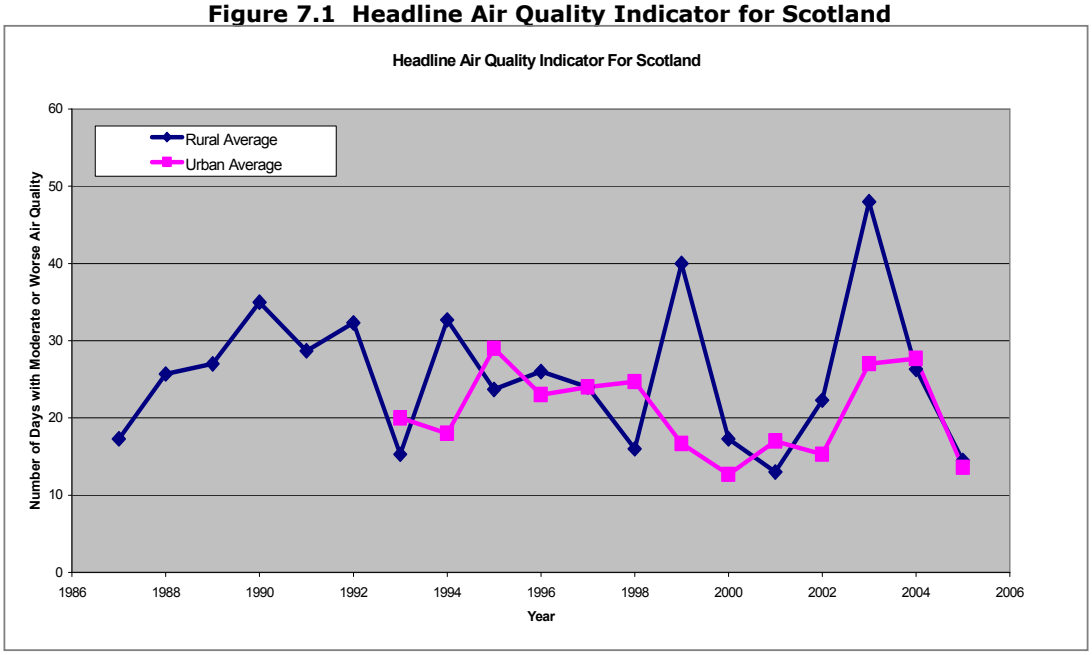
For the rural indicator which basically tracks ozone pollution episodes there are now four sites contributing, which for a regional pollutant should give a reasonable trend. In fact for all years except 2001 there are at least three monitoring sites included in the trends analysis. The absence of data for Strath Vaich in 2001 (only 58% data capture) may

explain the low result for this year, since the remote Strath Vaich location usually records a large proportion of the Moderate air pollution episodes for ozone in Scotland. It could therefore be debated that the 2001 result should be removed from this trend.

The results for the urban indicator should be treated with caution because:

- For the urban indicator there was only one Scottish monitoring site until 1997 (Glasgow City Chambers).
- In 2005 there were still only five monitoring sites contributing to the urban indicator. The local impact of any one monitoring site can therefore have a large impact on the overall indicator for Scotland.

Figure 7.1 Headline Air Quality Indicator for Scotland



There are some possible solutions to the problem with the urban headline indicator as follows:

1. Develop an indicator of trends based on analysis for specific pollutants, see section 7.2 below.
2. Improve the number of sites in the database - possible for recent years but unlikely to change the early years. Also there are unlikely to be many Local Authority sites measuring ozone.
3. Change the rules for the urban indicator so that more sites can be included. However, as a minimum ozone and PM_{10} would be required and hence, in practice, this is unlikely to increase the number of sites available.
4. Consider funding more ozone monitoring at urban background locations across Scotland.

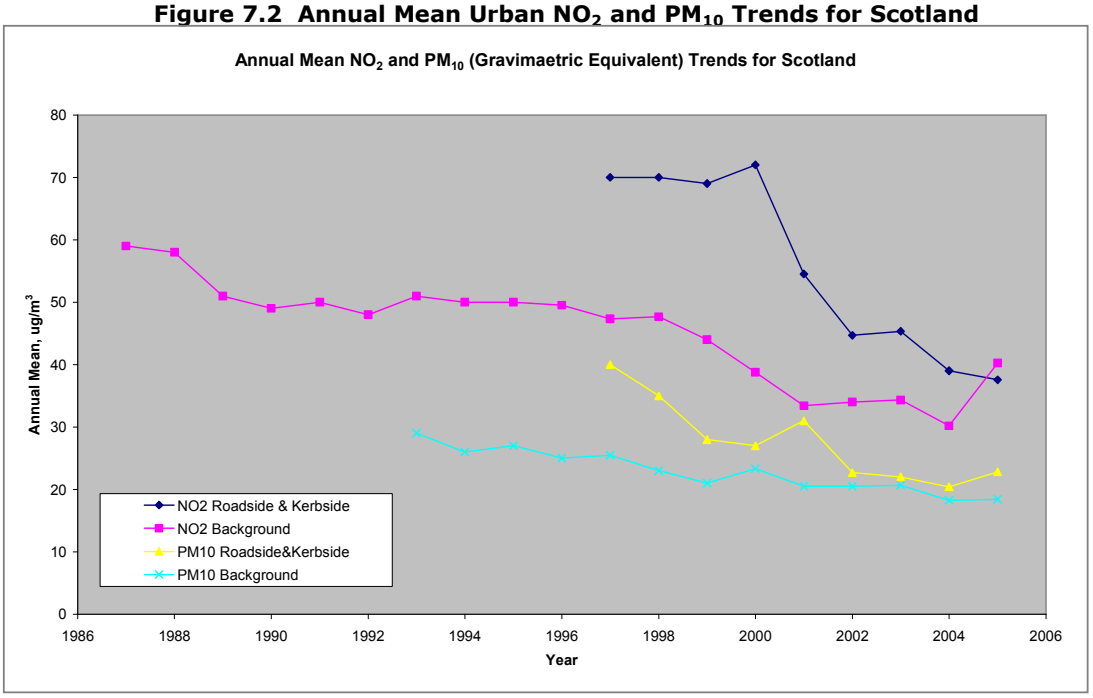
7.2 ANNUAL MEAN TRENDS FOR NO_2 AND PM_{10}

Following on from the difficulties encountered with the headline indicator trends for Scotland we have investigated the possibility of presenting trends analysis in a different format, as illustrated in Figure 7.2 overleaf.

This analysis takes annual mean concentrations for all the urban NO_2 and PM_{10} monitors in Scotland and splits them into categories for "Background" and "Roadside/Kerbside" locations. The values are then averaged across all the sites in each category for each year to produce a series of four trend lines as illustrated on the graph.

The PM_{10} trends are based on gravimetric equivalent data – converted using a factor of 1.3 for TEOM units.

Figure 7.2 Annual Mean Urban NO_2 and PM_{10} Trends for Scotland



These graphs all appear to show decreasing concentrations. However, there are once again difficulties with the number of sites available for presenting long-term trends, which need to be considered:

- For background NO_2 there is only one site (Glasgow City Chambers) available until 1992. From 1993 to 1996 there are two sites, and then from 1997 to 2005 the number of sites available increases from three to eight in total. Even eight sites is small for presenting a robust indicator, as is illustrated for 2005 where addition of two high pollution sites in Aberdeen to the database has caused a sharp rise in the trend.
- For Roadside/Kerbside NO_2 only one site is available until 2001. From here onwards the number of sites gradually increases from two to seven in 2005. Although the chart appears to show a downward trend this is mainly caused by lower pollution sites being included in later years, compared to the original Glasgow Kerbside site which is still by far the highest site in the database and has shown only a small decrease over time.

- For background PM_{10} the number of sites increases from one only in 1993 to five in 2005. Despite the small number of monitoring stations this trend does appear to be fairly robust with a consistent fall in concentrations across all the stations included in the analysis.
- For Roadside/Kerbside PM_{10} the number of sites increases from one only in 1997 to six in 2005. This trend appears to show a steeper downward slope than the background locations, but again it is dominated by Glasgow Kerbside in the earlier years and affected by the addition of lower concentration sites in later years.

8 Conclusions

AEA Energy & Environment has successfully developed a pilot study air quality web site and database for Scotland on behalf of the Scottish Executive. The web site and database are currently available as a password protected preview for stakeholders to review online at http://www.scotarc.aeat.com:

user name - scotarc
password - w3bsite

The web site and database have been developed so that they are robust, fully secure and easily expandable for future issue as a live web resource.

During the development of the pilot study web site and database a number of meetings and seminars were held to consult on the content and functionality of the system. This was found to be extremely beneficial with much positive feedback from Local Authorities, SEPA, health and statistics professionals and other bodies. A number of the recommendations were implemented during the pilot study phase, whilst others remain to be addressed should the pilot study go on to be developed into a fully live system.

For the purpose of the pilot study only examples of some reports and data were presented. This means that the database and web site are not currently fully populated with all available data and reports, another task which would need to be completed before launch as a live system.

A review of the quality and variety of air quality data collected across Scotland has also been carried out with a view to what may be available for an online database in the future. This has determined that within the national networks over 90 pollutant species are monitored, but at a relatively small number of monitoring sites. Monitoring undertaken by Local Authorities is much more extensive in terms of geographical coverage and site numbers (83 automatic sites and over 800 diffusion tube monitoring sites). It is recommended that in order to ensure comparability of results in a central database these data should be fully harmonised across Scotland with a consistency of data quality, calibration standards and site operating procedures across all monitoring sites.

As part of the Pilot Study a trial of new Weblogger technology for automatic data acquisition from air pollution monitoring sites over the internet was carried out. The Webloggers were supplied and installed by Air Monitors Ltd at six monitoring sites volunteered by Local Authorities across Scotland. AEA and the Local Authorities were also supplied with the required software to interrogate and analyse the results from the monitoring sites remotely. The ability of the Weblogger and software to provide hourly

data acquisition at lower cost than traditional data acquisition systems was successfully demonstrated, together with the facility to manually or automatically trigger calibration of the instruments remotely.

There were some technical difficulties with this part of the project due to the Webloggers having to be installed in parallel with other equipment at monitoring sites so as not to disrupt existing systems. This meant that the full Weblogger capability could not be demonstrated at all the sites. If the problems were minor suggest delete from conclusions – they are mentioned in the teaxt However, it was concluded that, overall, the Weblogger technology performed well (?) as part of the Pilot Study, and in some circumstances Local Authorities may decide that it would be beneficial to invest in this system. This study does not however constitute an endorsement of any kind of the product by AEA Energy & Environment or the Scottish Executive, and Local Authorities will need to carefully consider their own local circumstances when looking at the benefits or otherwise of the Weblogger system.

Air Quality mapping and trends analyses were carried out on the data gathered for the pilot study database. Both of these tasks achieved some improvements on the existing national scale studies based on National Monitoring Network data only. However, both concluded that results would be improved by gathering of further additional data to the database in future years in order to provide a more complete picture of the current and future air quality climate for Scotland.

Appendices

CONTENTS

Appendix 1
Scottish Automatic Monitoring Sites

List of Monitoring Sites and Locations in Each Local Authority

Council	Monitoring Site	Grid Ref	NOx	SO_2	CO	O_3	PM10 TEOM	PM10 BAM	PM10 grav-	PM10 Osiris	Comments
Aberdeen City	Aberdeen	394416, 807408	✓	✓	✓	✓	✓				AURN Urban site
	Aberdeen Union St	393630,805960 Estimate	✓				✓				Weblogger trial site AEA Calibration Club
	Aberdeen Anderson Drive	391610,805240 Estimate	✓				✓				AEA Calibration Club
	Aberdeen Market Street	394340,805950 Estimate	✓				✓				AEA Calibration Club
	Aberdeen Harbour	395320,806090					✓				AEA Calibration Club
Aberdeenshire	None										
Angus	Mobile site (part time)		✓	✓	✓		✓				
	Partisol site 1								✓		
	Partisol site 2								✓		
	Partisol site 3								✓		
Argyll and Bute	Tarbet Academy, Tarbet						✓				Plan to install 3 streetboxes on Islay
Clackmannanshire	Mobile PM10 site						✓				
Comairle nan Eilear Siar	None										
Dumfries and Galloway	Dumfries	297012,576278	✓		✓				✓		AURN Urban site
	Eskdalemuir	323500,602800	✓			✓					AURN Rural site (other pollutants monitored within other networks)
Dundee City	Union Street Rollalong	340247,730078	✓				✓			✓	AEA Calibration Club
	Broughty Ferry Rd, Rollalong	342270,731100 Estimate		✓			✓		✓		AEA Calibration Club
	Seagate, Romon	340540,730520 Estimate	✓								AEA Calibration Club
	Lochee Road, Romon	338920,730670 Estimate	✓								AEA Calibration Club
	Whitehall Street, Romon	340290,730160 Estimate	✓								AEA Calibration Club
	Dundee Scientific Services (Mains Loan)	341020,731920 Estimate					✓				Weblogger trial site AEA Calibration Club
	Dundee Osiris									✓	
	Dundee Osiris									✓	
East Ayrshire	Mobile Station		✓	✓	✓		✓				
East Dunbartonshire	Bishopbriggs	260940,669700 Estimate	✓					✓	✓		
	Bearsden	254260,672100 Estimate	✓					✓			
East Lothian	Musselburgh High St	334490,672640 Estimate	✓								
	Musselburgh	333950,672860					✓				

Council	Monitoring Site	Grid Ref	NOx	SO_2	CO	O_3	PM10 TEOM	PM10 BAM	PM10 grav-	PM10 Osiris	Comments
	North High St	Estimate									
East Renfrewshire	Barrhead Main St	250500,659100	✓								
	Sheddons Roundabout, Clarkston	257400,657000					✓				
City of Edinburgh	Edinburgh St Leonards	326200, 673100	✓	✓	✓	✓	✓				AURN Urban Site
	Queen Street	324890,674100 Estimate	✓				✓				
	Haymarket	323910,673190 Estimate	✓				✓				
	Roseburn Terrace	322900,673260 Estimate	✓				✓				Weblogger trial site
	St. John's Street Roundabout	319310,672940 Estimate	✓								
	Mobile site Currie, Edinburgh	317480,667780 Estimate	✓				✓				
Falkirk	Grangemouth (Inchyra)	293840, 681032	✓	✓			✓				AURN Urban site
	Grangemouth Municipal Chambers	292730,682060 Estimate	✓	✓	✓		✓				
	Falkirk Hope Street	288570,680250 Estimate	✓	✓	✓		✓				
	Falkirk Park Street	288910,680110 Estimate	✓	✓			✓				
	Mobile Unit 1	281300,682580 Estimate		✓	✓						
	Mobile Unit 2	Location not known	✓	✓			✓				
Fife	Kincardine, N. Approach Rd	293191,687518	✓								
	Rosyth, Admiralty Road	311752,683515	✓	✓	✓		✓				
	Cupar, Bonneygate	337401,714572	✓				✓				Weblogger trial site
Glasgow City	Glasgow Centre	258902, 665028	✓	✓	✓	✓	✓				AURN Urban site
	Glasgow City Chambers	259528, 665308	✓		✓						AURN Urban site
	Glasgow Kerbside	258708, 665200	✓		✓		✓				AURN Urban kerbside site
	Glasgow Anderston	257925,665487	✓	✓	✓		✓				AEA Calibration Club
	Glasgow Battlefield Road	258430,661390 Estimate	✓				✓				AEA Calibration Club
	Glasgow Byres Road	256510,666930 Estimate	✓		✓		✓				Weblogger trial site AEA Calibration Club
	Glasgow Waulkmillglen Reservoir	252520,658095	✓			✓	✓				AEA Calibration Club
	Glasgow Queen Street Station	259200,665520		✓			✓				AEA Calibration Club
Highland	Inverness	265720, 845680	✓		✓				✓		AURN Urban Site
	Fort William	210830, 774410	✓			✓					AURN Urban Site

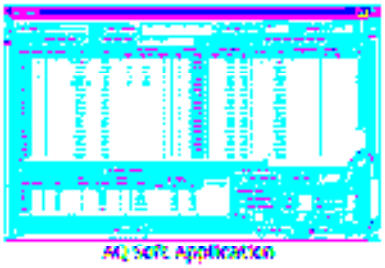
Council	Monitoring Site	Grid Ref	NOx	SO_2	CO	O_3	PM10 TEOM	PM10 BAM	PM10 grav-	PM10 Osiris	Comments
	Strath Vaich	234700, 875000				✓					AURN Rural site (other pollutants monitored within other networks)
Inverclyde	Mobile Unit shared with North Ayrshire		✓		✓		✓				
Midlothian	Bush Estate	324500, 663500	✓			✓					AURN rural site (other pollutants monitored within other networks)
	Auchencorth Moss	322000, 656200				✓			✓		AURN rural site (other pollutants monitored within other networks)
	Dalkeith	334000,667000 Estimate	✓	✓			✓				
	Pathhead	339400,664300 Estimate		✓			✓				
Moray	None										
North Ayrshire	Mobile Unit shared with Inverclyde Council		✓		✓		✓				Deployed in Irvine, North Ayrshire during 2005
North Lanarkshire	Chapelhall - Main Street/ Lauchope St,	278174,663124	✓				✓				
	Coatbridge Ellis Street,	273086,665077	✓								
	Coatbridge Calder Court	273668,663938					✓				
	Harthill Hirst Road, (Mobile 1)	288051,663975	✓	✓	✓		✓		✓		
	Croy Constarry Rd, (Mobile 2)	272775,675738	✓	✓			✓				
	Motherwell Hamilton Rd/ Merry Street	275148,657043	✓				✓				
	Chapelhall Main Street,	275148,657043	✓				✓				
Orkney	None										
Perth and Kinross	High St	311690,723626	✓				✓				AEA Calibration Club
	Atholl Street	311584,723930	✓				✓				AEA Calibration Club
Renfrewshire	Gordon St/ Causeyside Paisley	248320,663610	✓				✓				
	Central Rd, Paisley	248440,604190	✓								
	Glasgow Airport	248300,666540	✓						✓		
Scottish Borders	None										
Shetland	Lerwick	445337, 1139683				✓					AURN Remote site
South Ayrshire	Tarbolton	243100,626900 Estimate					✓				
	Sandgate, Ayr	233600,622000 Estimate								✓	
	Prestwick Academy	235700,626400 Estimate								**?**	?
South Lanarkshire	East Kilbride	264360,655650					✓				

Council	Monitoring Site	Grid Ref	NOx	SO_2	CO	O_3	PM10 TEOM	PM10 BAM	PM10 grav-	PM10 Osiris	Comments
		Estimate									
Stirling	Craigs Roundabout, A9 south	279960,692990	✓				✓				Commenced feb 2006
	Main Street, Cowie	283536,688906								✓	
West Dunbartonshire	Clydebank	250540,669390	✓								AEA Calibration Club
	Balloch	238590,681550	✓								AEA Calibration Club
West Lothian	Whitburn	294400,664100	✓	✓	✓		✓				Weblogger trial site May have moved to Manse Road (294708,664800)
	Linlithgow High St	300000,677100					✓				
Total	**Sites = 83**		**57**	**20**	**18**	**10**	**50**	**2**	**10**	**5**	

Appendix 2
Web Logger Technical Specification

AIR QUALITY WEBLOGGER

Weblogger


AQ Web Application

Introduction

The Air Monitors Weblogger allows air quality stations to communicate via the Internet using "always on" communications via GPRS (wireless) or Broadband (wired). There are several advantages over existing dial up connections, namely speed, cost and the ability to data manage and disseminate data more efficiently.

Specifications

- Solid state processor managing communication with multiple RS232 connections
- Most AQ manufacturers protocols are supported
- Analogue to digital converter for eight channels
- Digital inputs for four status signals (service, zero, calibration etc)
- Digital outputs for peripheral control (valves etc)
- Internal memory for backup storage of data
- Integral GPRS modem OR broadband connection
- Communication via TCP/IP to secure web server
- Transparent RS232 over TCP/IP for diagnostics and remote control
- Secure VPN managed SIM cards with fixed IP addressing
- Application software allows configuration of the logger for each site
- Display software provides instant tables & graphs of data
- Alarms can be set for status or concentrations
- Web page generator provides auto publishing via Internet

Summary

The Weblogger is programmed to communicate at regular intervals with a central data server allowing immediate back up of data from the site to a secure database. This database can then be accessed by any number of authorised users at broadband speeds and at no additional communications cost. The database provides support for a central data management system and can service multiple users simultaneously for reporting. The Weblogger in conjunction with the secure VPN communications network and advanced application software provides the most advanced site and data management capabilities available for air quality monitoring networks. It speeds up communication, saves on telephone costs, makes remote control of AQ sites more powerful and facilitates automation of many functions. Because the data is immediately backed up to an off site server fast access to the data is available to multiple simultaneous users making dissemination faster and easier than ever before.

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