BMT Cordah Limited
ENVIRONMENTAL CONSULTANCY
AND INFORMATION SYSTEMS

Review of Particulates

A Report for Angus Council

BMT Cordah Limited,
Pentlands Science Park,
Penicuik, Midlothian,
UK, EH26 0PZ.
Tel: +44(0)131 445 6120
Fax: +44(0)131 445 6110
Email: main@bmtcordah.com
Website: www.bmtcordah.com

Report No: BMT Cordah Ltd / AGC.007 / 2004
Status: Final
Version: Version 1
Date of Release: 22nd October 2004

Approved and authorised for issue:

Rebecca Chrystie, Consultant	Derek Schoehuys, Senior Consultant	Bill Sheridan, Principal Consultant

CONTENTS

Table, Chart and Figure Contents List

Glossary

AADT	Annual Average Daily Traffic (Vehicles per Day)
AQMA	Air Quality Management Area
AUN	Automatic Urban (air quality monitoring) Network
AURN	Automatic Urban and Rural (air quality monitoring) Network
Defra	Department for Environment, Food and Rural Affairs
DfT	Department for Transport
DMRB	Design Manual for Roads and Bridges Screening Model (v1.0g)
EFD (EFDB)	Emissions Factor Database
EIA	Environmental Impact Assessment
HDV	Heavy Duty Vehicles (Includes Rigid & Articulated HGVs, Buses and Coaches)
HGV	Heavy Goods Vehicles
Minor Roads	Non- A roads or motorways
NAEI	National Atmospheric Emissions Inventory
NETCEN	National Environment Technology Centre (AEA Environmental Technology)
NRTF	National Road Traffic Forecasts
OS	Ordnance Survey
ppb	Parts per billion
ppm	Parts per million
PM_{10}	Particulate matter with an (equivalent aerodynamic) diameter of ten microns (10µm) or less
$PM_{2.5}$	Particulate matter with an (equivalent aerodynamic) diameter of two and a half microns (2.5µm) or less
SEPA	Scottish Environment Protection Agency
TEOM	Tapered Element Oscillating Microbalance
UKAS	United Kingdom Accreditation Service
U&SA	Updating and Screening Assessment
WASP	Workplace Analysis Scheme for Proficiency

1. INTRODUCTION

Part IV of the Environment Act, 1995, places a statutory duty on local authorities to periodically review and assess air quality within their area to assess compliance with the standards and objectives set out in the National Air Quality Strategy (NAQS) for England, Scotland, Wales and Northern Ireland 2000 (Reference 1), the Air Quality Regulations 2000 (Reference 2) and Air Quality (Scotland) Amendment Regulations 2002 (Reference 3).

The air quality objectives for the purpose of Review and Assessment are shown in Table 1.

The second round of review and assessment commenced in 2003, with the Council submitting an Updating and Screening Assessment (U&SA) (Reference 4) report to the Scottish Executive in May 2003. The report concluded that there is potential for exceedence of the NAQS 2010 annual mean objective for PM_{10} based on local monitoring data although screening assessments of potential emissions sources within the Angus area did not identify any significant emissions.

No other NAQS objectives were predicted to be exceeded.

BMT Cordah Ltd has been commissioned by Angus Council to conduct a review of PM_{10} emission sources within the council area in order to identify the reasons for the high PM_{10} measurements. The review considers previous LAQM studies undertaken by BMT Cordah, local monitoring data and nationally available resources. The aim of the review is to assess likely compliance with NAQS objectives for PM_{10} with particular focus on the 2010 annual objective, and to identify potential emission sources to advise locations for monitoring of PM_{10}.

Assessment and monitoring of local air quality is carried out with reference to the technical guidance LAQM.TG(03) (Reference 5) and progress report guidance LAQM.PRG(03) (Reference 6). This report has been conducted in line with guidance from both sources.

Table 1: PM_{10} Objectives included in the Air Quality Regulations 2000 and (Amendment) Regulations 2002 for the Purpose of Local Air Quality Management

Pollutant	Objective		Date to be Achieved By
	Concentration	Measured As	
Particulates (PM_{10})	50µg/m^3 not to be exceeded more than 35 times per year[1]	24 hour mean	31.12.04
	40µg/m^3	Annual mean	31.12.04
	50µg/m^3 not to be exceeded more than 7 times per year[2]	24 hour mean	31.12.10
	18µg/m^3	Annual mean	31.12.10

[1] corresponds to the 90th percentile concentration of 24-hour means
[2] corresponds to the 98th percentile concentration of 24-hour means

1.1 Study Outline

The study seeks first to identify the background PM_{10} concentrations predicted across Angus and then assesses the recorded monitoring data and each identified emission source in turn to identify the source or sources of the measured exceedences.

A summary of previous air quality work undertaken for Angus Council is provided in Section 2. The projected background concentrations for the Angus area are discussed in Section 3, whilst the recorded monitoring data is discussed in Section 4 and each emission source is discussed in Sections 5-7 respectively.

2. PREVIOUS LAQM STUDIES

This review of PM_{10} sources draws heavily on previous work undertaken by BMT Cordah on behalf of the Council. BMT Cordah has been employed by the Council to undertake LAQM Review and Assessment and associated studies since the first round of Review and Assessment commenced in 1998.

The following studies have been referred to in this assessment of PM_{10}.

2.1 Stage 1 Review and Assessment

The Stage 1 Review and Assessment study (Reference 7) was undertaken as a screening study of emission sources within the Angus Council area, including industrial and road traffic sources. The study compared projected PM_{10} concentrations with the 2004 NAQS objectives. It was concluded that it was unlikely that there would be any exceedence of PM_{10} objectives therefore no further assessment of PM_{10} was required.

2.2 Revised Stage 1 Review and Assessment

Following the publication of technical guidance documents LAQM.TG1(00) to LAQM.TG4(00) (References 8 to 11) and monitoring undertaken by the Council, a revised Review and Assessment (Reference 12) was undertaken.

The study assessed industrial, road traffic and domestic emission sources and concluded that it was unlikely that emissions from any industrial or domestic sources would result in exceedence of the 2004 NAQS objectives for PM_{10}. Based on the screening method contained with the technical guidance, it was considered necessary to proceed to a Stage 2 Review and Assessment for road traffic sources.

2.3 Stage 2 Review and Assessment and Supplementary Report

The Stage 2 Review and Assessment (Reference 13) assessed emissions from road traffic. Emissions from the industrial processor Saccone Environmental, near Brechin, which had previously been unavailable, were also assessed.

DMRB calculations were undertaken to assess road traffic emissions on the busiest road within Angus, namely the A92 at Balmossie. The calculations concluded that the contribution of road traffic to the roadside PM_{10} concentration was approximately 1.2 $\mu g/m^3$. It was concluded that the combined background and road traffic contributions to PM_{10} concentrations would not exceed the 2004 annual mean objective of 40$\mu g/m^3$.

Dispersion modelling calculations were undertaken for industrial emissions from Saccone Environmental. The modelling predicted a maximum industrial contribution to ground level PM_{10} concentrations of 1.16 $\mu g/m^3$. It was concluded that it was unlikely that the combined background and road traffic contributions to PM_{10} concentrations would not exceed the 2004 annual mean objective of 40$\mu g/m^3$.

2.4 Environmental Review of Orchardbank Industrial Estate

A review of emissions to air from industrial processors contained within Orchardbank Industrial Estate was undertaken on behalf of the Council (Reference 14). The study identified two sources of PM_{10} emissions within the industrial estate, namely Ross & Bonnyman Shotblasting Services and Reekie Manufacturing Ltd. The report concluded that it was unlikely that the cumulative emissions of both sources would result in an exceedence of the 2004 NAQS objectives for PM_{10}.

2.5 Updating and Screening Assessment

The U&SA assessed the changes that had occurred since the first round of review and assessment. Road traffic, industrial, domestic and quarrying PM_{10} emission sources were assessed, primarily against the 2004 NAQS objectives. It was concluded that NAQS 2004 objectives for PM_{10} were unlikely to be exceeded, however based on local monitoring data there is potential for exceedence of the 2010 NAQS objectives for PM_{10}.

2.6 Industrial Processor Emissions Inventory

BMT Cordah compiled an inventory of emissions (Reference 15) from authorised and unauthorised emissions in the Angus area. The emissions inventory included PM_{10} emissions, which were plotted on a km^2 basis.

3. BACKGROUND PM_{10} CONCENTRATION

Predicted background PM_{10} concentrations were obtained from the NETCEN mapped data and database (Reference 16). The background concentrations are calculated from natural sources such as airborne spores, pollen grains, wind blown dust and sea salt particles, and estimates of industrial, vehicle, domestic, ship and aircraft emissions.

The background concentrations are predicted for both primary and secondary sources. Primary particulate sources are sources emitted directly to the atmosphere. Primary particulates can be defined as fine, e.g. from combustion sources, or coarse, such as resuspended or wind blown dusts and soils, organic and biological materials. Secondary particulates are formed from chemical reactions between other pollutants in the atmosphere. or coarse (originating from a wide variety of sources). The database of background concentrations are presented separately as secondary and primary concentrations. Primary concentrations include both fine and coarse PM_{10} concentrations.

The predicted background PM_{10} concentrations for Angus during 2004 and 2010 are summarised in Table 2. The predicted concentrations are plotted overlaid on digital mapping data in Figures 1 and 2 in Appendix 1 to allow identification of geographical profile of background concentrations.

Table 2: Background PM_{10} Concentrations for Angus Council (µg/m^3)

Year	Primary Background Concentrations	Secondary Background Concentrations	Total Background Concentrations
2004 Mean	12.71	3.41	16.12
2004 Minimum	12.00	3.18	15.18
2004 Maximum	14.50	3.56	17.96
2010 Mean	12.13	2.91	15.04
2010 Minimum	11.50	2.71	14.21
2010 Maximum	13.60	3.04	16.56

The results demonstrate that future background concentrations are predicted to decline due to reductions and expected improvements in fossil fuel burning efficiencies and a reduction in other emissions.

The highest predicted background PM_{10} concentration in 2010 is 17.96 µg/m^3 and is under the annual mean objective of 18 µg/m^3. The highest background concentrations are predicted in Forfar and in the areas surrounding the Ethiebeton quarry by Monifieth. The background concentration for the majority of Angus is predicted to be in the range 16-18 µg/m^3. The background concentrations in the rural areas to the north-west of Angus are predicted to be in the range 10-12 µg/m^3.

4. MONITORING

Monitoring for PM_{10} within Angus is undertaken on a periodic basis using a Tapered Element Oscillating Microbalance (TEOM) analyser contained within a mobile automatic monitoring station. The Council owns and operates the station in partnership with its neighbouring authorities.

Prior to November 2003 the monitoring instruments were rotated between the councils on a 3-monthly cycle. Angus Council monitored at three locations during their point in the cycle. These were:

- Carnoustie, a coastal location, to measure particulates arising from sea and to differentiate from the Ferryden area;
- Forfar, an inland location situated in a valley of an area where the local topography causes a microclimate with the potential to restrict dispersion of pollutants; and
- Ferryden near Montrose, in the vicinity of an area which has a number of authorised industrial processes.

Subsequent to November 2003, on the advice of the Scottish Executive, the monitoring periods were extended to 6 months in order to incorporate both summer and winter monitoring. The initial extended monitoring period commenced in November 2003 in Forfar.

The results of each monitoring period undertaken by the Council since 2000 are summarised in Table 3. The locations of monitoring within Angus Council are presented in Figure 3 in Appendix 1.

Table 3: PM_{10} Monitoring Results

Monitoring Period	Monitoring Location	Period Mean Concentration (µg/m^3)	Number of 24-Hour Mean Concentrations > 50µg/m^3
April – May 2000	Forfar	23	0
August – September 2000	Carnoustie	24	0
December 2000 – January 2001	Carnoustie	31	2
September – October 2001	Ferryden	27	0
January – February 2002	Forfar	24	0
June – July 2002	Ferryden	31	2
October – November 2002	Carnoustie	21	1
February – March 2003	Carnoustie	51	7
July – August 2003	Forfar	26	0
November 2003 – May 2004	Forfar	29	3

The mean measured concentration has therefore been greater than the 2010 annual mean objective of 18 µg/m^3 during each monitoring period. With the exception of the extended monitoring at Forfar in 2003-04 each monitoring period has been of a short duration. The results of the short duration monitoring may be affected by seasonal factors therefore they cannot be considered as representative of an annual mean concentration. The extended monitoring period at Forfar was undertaken across the winter months. In order to take account of any seasonal effect of winter meteorological conditions on PM_{10} concentration

the results have been adjusted using factors derived using methods contained within technical guidance LAQM.TG(03).

The technical guidance method applies a general principle that the seasonal effect on pollutant concentrations will be similar across a geographical area. There are no other PM_{10} monitoring stations within the Angus area and the nearest station, in Dundee city centre, experienced technical difficulties during 2003 therefore insufficient data was available. The next closest monitoring sites are at Falkirk and Aberdeen. Although both sites are situated at distance from Forfar the measured results from each site have been used to determine the seasonal variation in PM_{10} concentrations. The calculated variation is summarised in Table 4.

Table 4 Estimation of Ratio of Short-term Monitoring to Annual Mean Concentration

Dates	Monitoring Site	Annual Mean Concentration (µg/m^3) (2003)	Period Mean Concentration (µg/m^3)	Ratio (Am/Pm)
Nov 03 - May 04	Aberdeen City	22.1	20.8	1.063
Nov 03 – May 04	Falkirk	19.5	16.4	1.190
			Average (Ra)	1.126

The results from the two other monitoring sites indicate that the mean concentration over the period November to May is less than the measured annual mean concentration during 2003.

A projected annual mean concentration can therefore estimated by the following:

Forfar Annual mean (2003) = Forfar period mean x Ra
= 29 x 1.126 = 32.654µg/m^3

Technical guidance document LAQM TG (03) provides guidance on projecting forward the predicted annual mean concentration of PM_{10}. The annual mean concentration has therefore been projected forward to 2010 using the techniques contained with LAQM TG (03). The method used for the projection is summarised in Box 4.1.

Box 4.1

The annual mean concentration for 2003 was calculated as 32.654µg/m^3 (gravimetric).

Secondary Concentration 2001(from maps)	= 3.65µg/m^3
Coarse PM_{10} fraction (from LAQM.TG (03))	= 10.5µg/m^3
Secondary concentration 2003	= 3.65µg/m^3 x 0.955 = 3.49µg/m^3
Secondary Concentration 2010	= 3.65µg/m^3 x 0.795 = 2.90µg/m^3
Primary Concentration 2003	= 32.654 – 3.49 – 10.5 = 18.668µg/m3
Primary Concentration 2010	= 18.668 x (0.815/0.954) = 15.95µg/m^3
Total PM_{10} Concentration 2010	= 15.95 + 2.90 + 10.5 **= 29.35µg/m^3**

The total projected PM_{10} concentration for Forfar in 2010 therefore exceeds the 2010 annual mean NAQS objective of 18µg/m^3.

Three exceedences of the 24-hour mean objective of 50µg/m^3 were recorded in the period of Nov 2003 – May 2004 and seven exceedences are permitted by 2010. There is no data available for the number of exceedences over the course of a year.

The number of exceedences of the 24-hour mean objective cannot be directly projected forward to future years. However, the LAQM.TG(03) technical guidance provides a method for estimating the number of 24-hour exceedences of 50µg/m^3 based on the annual mean. The method used for the projection is summarised in Box 4.2.

Box 4.2

No. of Exceedences = -18.5 + 0.00145 * (annual mean)^3 + (206 / annual mean)

For 2010

No. of exceedences = 0.00145 * 29.35^3 + (206 / 29.35) -18.5

= 25.18

= 25 exceedences

The number of exceedences of the 24-hour mean objective of 50µg/m^3 estimated for 2010 at Fofar is 25. This is above the permitted seven exceedences within a year, therefore it is predicted that the 24-hour mean PM_{10} objective for 2010 will be exceeded at Forfar.

5. ROAD TRAFFIC SOURCES

Road traffic sources generate emissions of PM_{10}, particularly from diesel powered cars and heavy goods vehicles.

5.1 Summary of Previous Assessments

The first Review and Assessment of air quality for Angus Council stated that no single 1km grid square was estimated to possess more than 10 tonnes of PM_{10} emissions per year and that there were no instances of adjacent grid squares containing an average of 5 tonnes or above per year. One section of the A90 was identified as expecting to exceed 25,000 AADT flow. However it was concluded that further consideration of PM_{10} emissions from vehicles was not required due to the lack of relevant public exposure along the route.

The Revised Review and Assessment of Air Quality for Angus Council carried out in 2001 (Reference 8) concluded that, following pollutant specific guidance for PM_{10}, several routes within the area met the criteria to proceed to a Stage Two Assessment. The criteria for further assessment was roads possessing an AADT flow greater than 5,000 with residential properties located within 100m of the route.

The Supplementary Air Quality Report for Angus Council used the methods set out in technical guidance LAQM.TG(00) to assess the likelihood of exceedence of the 2004 PM_{10} NAQS objectives as a result of traffic flow on the 6 roads of greatest AADT within the Council area. The roads were assessed using nomogram charts based on the method contained within the Design Manual for Roads and Bridges (Reference 17) .The roads assessed were:

- A92, J11 at Balmossie;
- A92, J8 at Burnside Drive, Arbroath;
- A930, J1 at Ferry Road, Monifieth;
- A92, J10 AT Balmachie;
- A92, J9 at Nether Kelly; and
- A92, J1 at North Esk Road.

The location of all assessed junctions is presented in Figure 4 in Appendix 1.

It was concluded that there was no potential for exceedence of the 2004 NAQS objectives for PM_{10} at any of the locations assessed. No assessment of PM_{10} was conducted for the 2010 NAQS objectives.

The U&SA for Angus Council conducted in 2003 reassessed traffic emissions using the revised DMRB Assessment model and recent traffic flow data for the 6 roads highlighted in

the first round of Review and Assessment. The assessment considered traffic flows predicted for 2005 and 2010 and concluded that there was no potential for exceedence of either the 2004 or 2010 NAQS objectives for PM_{10} at any of the locations assessed.

5.2 Assessment against the 2010 PM_{10} NAQS Objective

The U&SA assessed the traffic emissions predicted for 2010 at six road junctions within Angus Council assuming traffic speeds of 40mph and 60mph. The predicted traffic emission contribution and background concentrations for roadside receptors (within 5m of road centre) on each road assuming an average speed of 40 mph are presented in Table 5. The predicted roadside concentrations assuming an average speed of 60 mph. are summarised in Table 6.

Table 5: Predicted Roadside PM_{10} Concentrations at 40 mph (µg/m^3)

Location	Road Traffic Contribution (µg/m^3)	Background Concentration (µg/m^3)	Overall Concentration (µg/m^3)
A92 J1 North Esk road	1.56	15	16.56
A92 J8 Burnside Dr, Arbroath	1.70	15	16.70
A92 J9 at Nether Kelly	1.90	15	16.90
A92 J10 at Balmachie	2.02	15	17.02
A92 J11at Balmossie	2.10	15	17.10
A930 J1-Ferry Rd, Monifieth	1.71	15	16.71

Table 6: Predicted Roadside PM_{10} Concentrations at 60 mph (µg/m^3)

Location	Road Traffic Contribution (µg/m^3)	Background Concentration (µg/m^3)	Overall Concentration (µg/m^3)
A92 J1 North Esk road	1.68	15	16.68
A92 J8 Burnside Dr, Arbroath	2.05	15	17.05
A92 J9 at Nether Kelly	2.17	15	17.17
A92 J10 at Balmachie	2.31	15	17.31
A92 J11at Balmossie	2.46	15	17.46
A930 J1-Ferry Rd, Monifieth	2.16	15	17.16

The DMRB calculations therefore predict that roadside concentrations alongside these busy roads will remain below 18µg/m^3 in 2010. Furthermore, the roads are all main trunk roads, therefore the number of roadside receptors alongside each road are limited. It is therefore considered unlikely that these roads will contribute to an exceedence of the annual mean PM_{10} objective in 2010.

Whilst the roads considered are all generally free-flowing trunk roads there are also roads within the main market towns of Angus that will be subject to slower traffic movements at road junctions. In particular Forfar town centre has a number of junctions and narrow streets with potential to form street canyons. Traffic flow levels are however relatively light and congestion is rare.

6. INDUSTRIAL SOURCES

An inventory of atmospheric emissions from SEPA authorised and non-authorised industrial sources within Angus was undertaken in 2003. The inventory identified a number of sources of PM_{10}. These sources are summarised in Table 7. Data relating to annual PM_{10} emissions from each source was obtained from regulatory permit applications to SEPA and associated monitoring data.

Table 7 Industrial Sources within Angus with Atmospheric PM_{10} Emissions

Source	Process	Location	Annual PM_{10} Emission (te/annum)
Angus Fertilisers	Fertiliser Production (Combustion)	rural, near Friokheim	2.00
Saccone	Abbattoir (Incineration)	rural, near Brechin	5.00
Glaxo 2	Chemical Manufacturing	Montrose	10.00
Parkgrove Crematoria	Crematoria (Incineration)	Friokheim	10.00
Waulkmill Quarry	Combustion	rural, near Inverkeilor	10.00
Cossack Garage	Combustion (WOB)	Kirriemuir	1.95
Careston Motors	Combustion (WOB)	Brechin	1.95
Forfar Galvinisers	Galvanising	Forfar	1.60
Maryton Garage	Combustion (WOB)	Kirriemuir	1.95
D F &A Collie	Combustion (WOB)	Brechin	1.22
G&N Wishart	Combustion (WOB)	Friockheim	1.22
Campmuir	Combustion (WOB)	Forfar	1.22
Baldowrie Garage	Combustion (WOB)	Monifieth	1.22
Butler Motors	Combustion (WOB)	Forfar	1.22
Bill Stephen Motors	Combustion (WOB)	Brechin	1.22
Stewart Butchart Motors	Combustion (WOB)	Monifieth	1.22
Baldoukie Motors	Combustion (WOB)	rural, near Forfar	1.22

The impact of each industrial emission was assessed using nomogram methods contained within Technical Guidance LAQM.TG(03). The nomograms were developed following extensive dispersion modelling of various emission scenarios providing a series of predicted ground level concentrations for certain emission sources. The nomograms provide a screening assessment level to determine the significance of the industrial emissions. The nomograms estimate the emission rate that would produce an annual mean ground level concentration of 1 $\mu g/m^3$ for a given stack height and emission conditions.

All emissions were assumed to be at a low temperature thereby negating any thermal buoyancy effect on plume dispersal as a worse case scenario. In addition, emissions from garages were assumed at roof height, which when the effect of buildings on plume dispersal is taken into account, were considered to be an effective ground level release.

Two nomogram charts were used for the assessment, one for stack releases at height greater than 10m and one for an effective ground level release. The nomogram for releases at heights greater than 10m is provided in Figure 5 whilst the nomogram for effective ground level releases is provided in Figure 6.

The estimated annual release rate of PM_{10} from the nomograms was compared with the actual release. Industrial sources with an actual emission rate less than the estimated annual release rate obtained from the nomograms were considered to be insignificant in

terms of contribution to ground level PM_{10} concentrations. The comparative results for sources with stack heights greater than 10 metres are summarised in Table 8, whilst the results for effective ground level release are summarised in Table 9.

Table 8 Particle emissions from stacks greater than 10m giving rise to an annual mean ground-level concentration of 1µg/m^3 (stack >10m)

Processor	Actual PM_{10} Emission (te/annum)	Estimated PM_{10} Emission from Nomogram (te/annum)
Angus Fertilisers	0.57	2.00
Saccone	0.44	5.00
Glaxo 2	0.07	10.00
Parkgrove Crematoria	0.59	10.00
Waulkmill Quarry	16.08	10.00
Cossack Garage	1.22	1.95
Craeston Motors	1.22	1.95
Forfar Galvinisers	0.73	1.60
Maryton Motors	1.22	1.95

Table 9 Particulate emissions from effective ground level sources that will give rise to an annual average ground level concentration of 1 µg/m^3 at receptors within 2km of source

Processor	Quantity Emitted	Distance of receptor from source(m)
D F &A Collie	1.22	150
Station Road	1.22	150
Station Yard	1.22	150
Baldowrie Garage	1.22	150
Charles Engineering	1.22	150
Bill Stephen Motors	1.22	150
Stewart Butchart Motors	1.22	150
Baldowrie Motors	1.22	150

The results therefore demonstrate that with the exception of the point source emissions from Waulkmill Quarry the PM_{10} emissions from sources with stack heights greater than 10m are insignificant in terms of ground level concentrations (i.e. predicted ground level concentrations are less than 1µg/m^3). Emissions from Waulkmill Quarry are predicted to have potential to contribute over 1 µg/m^3 to ground level PM_{10} concentrations in the vicinity of the site.

The nomograms assume worst case dispersion conditions which occur infrequently in the UK. A screening dispersion modelling run was therefore undertaken to ascertain the impact of emissions from the site during more frequently occurring meteorological conditions. The results of the modelling study are summarised in Section 6.1.

The nomogram assessment of minor PM_{10} sources that were considered as an effective ground level release concluded that each emission source may contribute up to 1 µg/m^3 of PM_{10} to overall ground level concentrations at distances up to 150m from source. The emissions from these sources were calculated as a worst case continuous emission, whereas in reality the emissions from these sources will be intermittent. It is therefore considered unlikely that these sources will contribute 1 µg/m^3 to the annual mean ground level concentration; however it is likely that a contribution of this magnitude may be made over short term periods in the immediate areas surrounding the sources.

No further assessment of the minor emission sources has therefore been made, although it is recognised that these sources may contribute to short term ground level concentrations and may impact it addition to other sources.

6.1 Screening Modelling of PM_{10} Emissions from Waulkmill Quarry

An assessment of the impact of PM_{10} emissions from plant within Waulkmill Quarry was undertaken using dispersion model ADMS 3 (version 3.1). ADMS 3 is a new-generation dispersion model and has been approved for use by both the SEPA and the Environment Agency.

The screening modelling assessment assumed an average emission from the site and assessed the impact of that emission during a set of meteorological conditions representative of the old Pasquill-Gifford stability categories that were used prior to the development of new-generation models such as ADMS. The source input data to the model is presented in Table 10, whilst the meteorological conditions are summarised in Table 11.

Table 10 Dispersion Modelling input Data

Parameter	Value
Stack Height (m)	20
Stack Diameter (m)	1
Exit Velocity (m/s)	15
Exit Temperature (^{O}C)	60 (assumed)
PM_{10} Mass Emission rate (g/s)	0.51
Surface Roughness (m)	0.3

Table 11 Meteorological Conditions Representative of Pasquill-Gifford Stability Classes

Approximate Pasquill Stability Equivalent	Wind Speed (m/s)	Net Solar Heat Flux (W/m^2)	Boundary Layer Height (m)
A	1	113	1300
B	2	84	900
C	5	74	850
D	5	0	800
E	3	-10	400
F	2	-6	100
G	1	-0.6	100

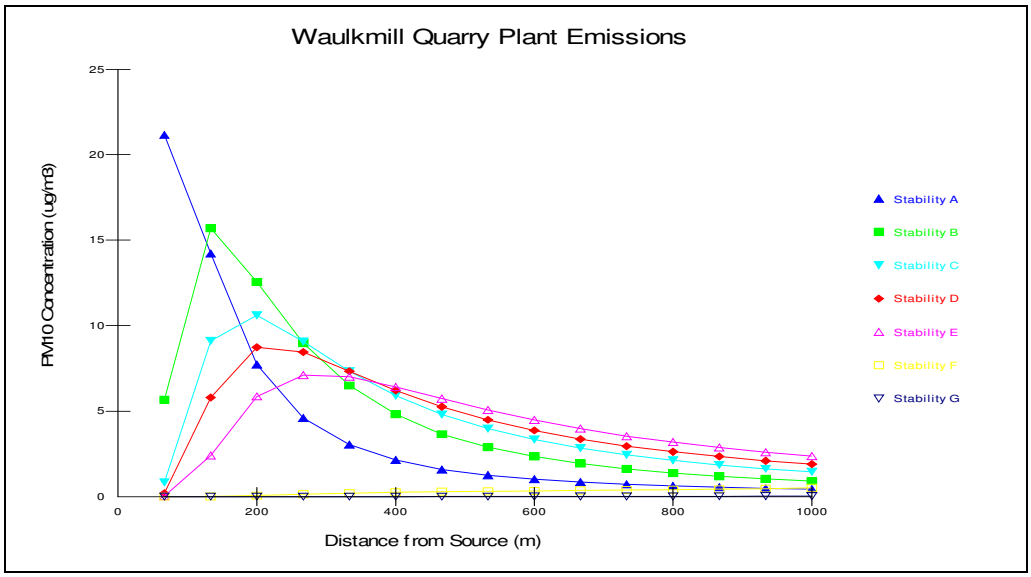
The maximum ground level concentrations predicted by the model and their distance from the source for emissions in each stability category are summarised in Table 12. The predicted concentrations plotted against distance from source are represented graphically in Chart 1. The predicted concentrations are representative of maximum hourly concentrations.

The results demonstrate that for the most common stability conditions, namely stabilities C, D and E, that emissions from the plant will contribute between 5-10 $\mu g/m^3$ to the maximum hourly PM_{10} concentration within a 200m radius. At a distance of 1km the predicted hourly ground level concentrations for these stability categories is approximately 2-3 $\mu g/m^3$. The Waulkmill Quarry is situated in a rural area with limited sensitive receptors within the vicinity of the quarry. There are however three residential receptors situated within 400m of the quarry, with the closest located within a distance of 300m.

Table 12 Maximum Predicted PM_{10} Ground Level Concentrations Attributable to Emissions from Waulkmill Quarry Plant

Stability Category	Maximum Predicted Ground Level PM_{10} Concentration ($\mu g/m^3$)	Distance from Source (m)
A	21.16	67
B	15.71	133
C	10.61	200
D	8.75	200
E	7.11	267
F	0.50	1000
G	0.02	1000

Chart 1: Predicted Ground Level PM_{10} Concentrations Attributable to Emissions from Waulkmill Quarry Plant



At a distance of 300m the highest predicted ground level contributions for stability classes C, D and E are approximately 6-8 $\mu g/m^3$. The background PM_{10} concentration in the vicinity of the Waulkmill Quarry is approximately 14 $\mu g/m^3$. As emissions from the plant are intermittent it is considered unlikely that the contribution to the annual mean concentration in the vicinity of the plant will be greater than 4$\mu g/m^3$. There are no other emission sources in the vicinity of the plant with the exception of a minor road. It is therefore considered unlikely that there will be an exceedence of either the annual mean or 24-hour mean PM_{10} objectives in 2010 in the vicinity of Waulkmill Quarry.

No complaints regarding dust nuisance from Waulkmill Quarry have been received by Angus Council and the council is unaware of any complaints regarding dust from the facility lodged with the operator or SEPA.

7. DOMESTIC SOURCES

The burning of solid fuels in high density for domestic purposes can lead to the potential to exceed NAQS objectives for PM_{10}. Solid fuels include coal and Solid Smokeless Fuels (SSFs) such as anthracite or furnacite.

7.1 Summary of Previous Assessments

No specific assessment of PM_{10} from domestic fuel sources was conducted for the first Air Quality Review and Assessment

The Revised Stage 1 Review and Assessment of Air Quality in Angus Council concluded that there were no areas measuring 1 kilometre square where more than 300 properties burn coal. Therefore it was concluded that domestic fuel was not a significant source of atmospheric PM_{10} within the area.

The U&SA used criteria set out in the technical guidance LAQM.TG(03) to assess the potential for exceedence of the PM_{10} NAQS objectives from domestic fuel sources. Based on information for council houses it was concluded that no areas of 500m by 500m would contain more than 50 properties burning solid fuel. A similar distribution of solid fuel burning properties was expected for privately owned and housing association properties although no data was available on these properties for assessment. It was therefore concluded that domestic fuel burning was unlikely to have the potential to exceed NAQS objectives for PM_{10}.

A further investigation in to domestic fuel burning was carried out by Angus Council during July 2004. The study included site visits to various towns and communities within Angus and concluded that domestic emissions within the main towns were not significant. However, the report identified 24 settlements outside of the main towns which warrant further investigation. On the recommendation of SEPA 2 or 3 of the worst case locations will be assessed further during the winter months of 2004 / 2005 (Reference 18).

8. QUARRIES AND LANDFILL SOURCES

Emissions of PM_{10} from quarries, landfills and other dust emitting processes are considered in terms of fugitive emissions. With the exception of crushing machinery most operations taking place at landfills and quarries that lead to emissions of PM_{10} are not contained and therefore difficult to quantify. The assessment of quarries is therefore based on distance from potential receptors and background concentrations.

The first stage Air Quality Review and Assessment highlighted three quarries operational within Angus Council registered as Part B industrial processes. No monitoring data was available for the sites and it was concluded that due to the relatively small scale of the operations few, if any of the operations would emit significant quantities of PM_{10}.

The U&SA undertook a review of quarries in the Angus area in 2003 and identified a number of quarries with both potential to emit PM_{10} and with sensitive receptors in the surrounding areas. Ethibeaton Quarry, by Monifieth, was identified as an emission source with nearby receptors, as was Fledmyre Quarry on the outskirts of Forfar. In addition the Boysack Quarry, near Friockheim is due to be re-opened by 2006. It was considered that none of these quarries were likely to have significant impact on PM_{10} concentrations in comparison to the 2004 NAQS objectives. No assessment was however made against 2010 NAQS for PM_{10}.

Adjacent to the Fledmyre Quarry, at Gowanbank, Forfar is the Council Landfill Site which has, historically, been subject to dust complaints from nearby residents during construction phases. No complaints have been made against the site in recent times.

Technical guidance LAQM.TG(03) indicates that the contribution of dust emitting sources to PM_{10} concentrations at a distance of 400m from source is unlikely to be greater than $2\mu g/m^3$. The background concentration in Forfar (avoiding double-counting of emission sources in grid squares) is $15\mu g/m^3$. It is therefore unlikely that the annual mean PM_{10} objective will be exceeded in Gowanbank, Forfar as a result of emissions from the quarry and landfill site.

Similarly it is considered unlikely that there will be an exceedence of the annual mean PM_{10} objective in 2010 at receptors close to the Ethibeaton Quarry or Boysack Quarry.

9. STUDY FINDINGS AND CONCLUSIONS

Monitoring undertaken for PM_{10} within Angus indicates that there is potential for exceedence of the 2010 NAQS objective, with measured mean PM_{10} concentrations regularly close to 30µg/m^3. Historical monitoring data within Angus has been of short duration (less than 3 months) and as such the measured results may be subject to seasonal factors or anomalies. Monitoring over an extended monitoring period of 6 months was undertaken in Forfar during Winter 2003 to May 2004. The measured concentration over the period was consistent with previous short-term monitoring results, indicating a projected annual mean concentration of 29µg/m^3 in 2010.

The current monitored concentration, projected annual mean concentration and number of 24-hour mean exceedences in Forfar are predicted to exceed the annual mean and 24-hour mean objectives for 2010. However, the screening assessment of potential emission sources in Forfar, and throughout Angus, did not identify any potential for exceedence of the 2010 annual mean objective of 18µg/m^3. The results of the screening assessment and monitoring data do not correlate indicating that there are some sources of PM_{10} unaccounted for by the screening assessment.

Angus is a mainly rural area with large tracts of agricultural land growing crops or commonly oil seed rape. Pollen in air or re-suspended dust resulting from agricultural activities may impact upon ambient PM_{10} concentrations, particularly pollen which can travel large distances.

At coastal locations, particularly at the monitoring sites in Arbroath and Carnoustie salt in air, generated by sea-spray may also contribute to ambient PM_{10} levels.

Further work is therefore required to determine the sources of the high PM_{10} concentrations. Angus Council has therefore proposed to undertake gravimetric sampling for PM_{10} at three locations within Angus. Analysis of the filters post monitoring will allow the Council to determine the nature of the particulate material, for example whether the material is coarse grit or pollen, or whether the material is sea-salt based. Comparison of the monitored concentrations, source apportionment analysis and subsequent review of sources will allow the Council to better understand the high concentrations of $PM_{10,}$ and develop measures to improve PM_{10} concentrations, if possible.

The study did not determine any dominant PM_{10} sources within Angus, however it is recommended that monitoring be undertaken within Forfar, at a coastal site (Carnoustie) and at a rural background site in an agricultural area.

10. REFERENCES

Reference 1 Air Quality Strategy for England, Scotland, Wales and Northern Ireland 2000

Reference 2 Air Quality Regulations 2000

Reference 3 Air Quality (Scotland) Amendment Regulations 2002

Reference 4 Local Air Quality Management Updating and Screening Assessment for Angus Council, 2003, BMT Cordah Ltd Report Ref: AGC.005.

Reference 5 Local Air Quality Management, Technical Guidance, LAQM.TG(03), DEFRA, 2003

Reference 6 Local Air Quality Management, Progress Report Guidance, LAQM.PRG(03), DEFRA, 2003

Reference 7 Angus Council Air Quality Review and Assessment, February 1999, BMT Cordah, Report Ref. AGC.001

Reference 8 Local Air Quality Management LAQM.TG1(00) Review and Assessment: Monitoring Air Quality, Scottish Executive 2000

Reference 9 Local Air Quality Management LAQM.TG1(00) Review and Assessment: Estimating Emissions, Scottish Executive 2000

Reference 10 Local Air Quality Management LAQM.TG1(00) Review and Assessment: Selection and Use of Dispersion Models, Scottish Executive 2000

Reference 11 Local Air Quality Management LAQM.TG1(00) Review and Assessment: Pollutant Specific Guidance, Scottish Executive 2000

Reference 12 Revised Stage 1 Review and Assessment of Air Quality for Angus Council, 2001, BMT Cordah Ltd Report Ref: AGC.002

Reference 13 Supplementary Air Quality Report for Angus Council, 2002, BMT Cordah Ltd Report Ref: AGC.003

Reference 14 Environmental Review: Orchardbank Industrial Estate, 2003, BMT Cordah Ltd Report Ref: AGC.004.

Reference 15 Inventory of Emissions from Industrial Processes within Angus, 2003, BMT Cordah Ltd Report Ref: AGC.006

Reference 16 NETCEN, AEA Technology, Air Quality Database

Reference 17 Design Manual for Roads and Bridges (DMRB), Volume 11 Environmental Assessment, Section 3, Part 1: Air Quality, Scottish Executive 2003

Reference 18 Domestic Coal – Burning in Angus, Angus Council, July 2004

APPENDIX 1 - FIGURES