14.0 FIRST STAGE REVIEW AND ASSESSMENT OF FINE PARTICLES (PM_{10})

14.1.1 Introduction

PM_{10} are fine particles suspended in the atmospheric air which due to their size and aerodynamic characteristics are able to be inhaled and reach the lungs. In simple terms, PM_{10} are so called because the aerodynamic diameter of the particles is less than 10μm ie 10 millionth of 1 metre. In the Air Quality (England) Regulations, 2000 PM_{10} is defined as the mass fraction of particles which if inhaled would penetrate beyond the larynx, as defined in ISO Standard 7704.

Prior to the late 1960s domestic burning of coal in towns and cities was an important contributor to 'smogs'. The Clean Air Act, 1956 improved the air by largely removing the two main constituents, namely sulphur dioxide and smoke particles. The increase in the number of motor vehicles and subsequent research have shown that much smaller particles may still be causing effects on health. This is the case even at concentrations far lower than those recorded in the past. This has resulted in sulphur dioxide and PM_{10s} inclusion in the AQS.

Unlike the other pollutants considered in this report which are single, well defined chemical substances, this pollutant is characterised by its physical properties, and may be of different chemical constituents depending on its source. Examples of man-made primary sources are: carbon particles from incomplete combustion, ash, re-condensed metallic vapours and so called secondary particles or aerosols, formed by chemical reactions in the atmosphere. In addition to being emitted directly from combustion sources, man-made particles can arise from: mining, quarrying and construction operations; brake and tyre wear in motor vehicles; and from road dust lifted by moving traffic or strong winds. Natural sources of particles include windblown dust from agricultural activity and importantly for coastal authorities, sea salt and biological particles such as pollens and fungal spores. A significant proportion of the current annual mean PM_{10} is due to the secondary formation of particulate sulphates and nitrates, resulting from the oxidation of sulphur and nitrogen oxides. Of particular concern are particles emitted by motor vehicles as they may carry carcinogens which have been absorbed onto the surface of the particle.

In the UK the main source of PM_{10} is industry and power generation contributing approximately 59% of the total with road transport contributing a further 26%. The remainder is produced by domestic and other sources (Tables 2 and 4). It should be noted that, in general, the emissions estimates for PM_{10} are less accurate than those for the other pollutants with prescribed objectives, especially for sources other than road transport.

It should be noted that since the draft 1st stage review and assessment was published in Spring 1999 the Government has undertaken further research on PM_{10} which has given rise to modified technical guidance. The 1st stage review and assessment has been comprehensively modified to accommodate the current position.

14.1.2 Standard and Objective

The Government has adopted two air quality objectives for fine particles (PM_{10}), which are equivalent to the EU Stage 1 Limit Values. The objectives are 40 $\mu g/m^3$ as the annual mean, and 50 $\mu g/m^3$ as the fixed 24-hour mean to be exceeded no more than 35 days per year, to be achieved by the end of 2004. The objectives are based on measurements carried out using the European gravimetric transfer reference sampler or equivalent (see Section 14.1.4 for further details).

The focus of the Authority's review and assessment for PM_{10} has been the following non-occupational locations where the public might be regularly exposed:-

- background locations;
- roadside locations (sites close to the façade of a building);
- other locations where potentially significant groups might be exposed, such as schools or hospitals.

14.1.3 National Perspective

There is a wide range of emission sources which contribute PM_{10} concentrations in the UK. These can usefully be divided into 3 main source categories (DETR, 2000)[3].

- *Primary Combustion Particles* - particles emitted directly from combustion processes such as road traffic, power generation, industrial combustion processes etc. These particles are generally less than 2.5 µm and often well below 1 µm in diameter;
- *Secondary Particles* - particles formed in the atmosphere following their release in the gaseous phase. These include sulphates and nitrates, formed from emissions of SO_2 and NO_x; these particles are again generally less than 2.5 µm in diameter;
- *'Coarse' or 'Other' Particles* - the so-called 'coarse' or 'other' particles component comprises emissions from a wide range of non-combustion sources. These include resuspended dust from road traffic, construction and mineral extraction processes, wind-blown dusts and soils, and sea salt. These particles are generally greater than 2.5 µm in diameter.

These are several reasons why it is important to bear in mind the different source categories, and their respective contribution to PM_{10} concentrations, within the review and assessment process:-

- The expected reduction in particle emissions in future years is different for each type of source. For example, emissions from road transport will be governed by new legislation on vehicle emission standards; emissions of secondary particles will be largely governed by controls on power generation, industrial and transport SO_2 and NO_x emissions, both in the UK and in Europe; emissions of coarse particles are largely uncontrolled, and in general are not expected to decline in future years. In forecasting future emissions it is therefore essential to treat each source category separately. It should be noted that it is not appropriate to extrapolate measured PM_{10} concentrations forwards to 2004 using a simple trend analysis (eg plotting measured PM_{10} concentrations between 1992 and 1998 and then extrapolating this line to 2004).
- The principal focus of Local Air Quality Management should be towards the control of emissions at a local level. Review and assessment therefore aims to identify the contribution of local emission sources, so that the effectiveness of control policies or action plans can be evaluated.

A description of the different source categories, and their approximate contribution to annual mean background concentrations is described in Figure 19. A significant proportion of current annual mean PM_{10} is derived from regional (including long distance transport from Europe) background sources. The exact regional background contribution at any site is variable, and will be dependent upon the precise geographic location. Typical regional annual mean background contributions are currently within the range of about 18 - 26 µg/m^3, gravimetric and are outside of the control of Local Authorities. Where exceedances of the objective are predicted, Local Authorities should focus their efforts on the identification of the contribution of local sources to overall PM_{10} concentrations according to TG4(00) DETR (2000)[3].

Figure 19. Approximate contributions to PM10 concentrations 1998

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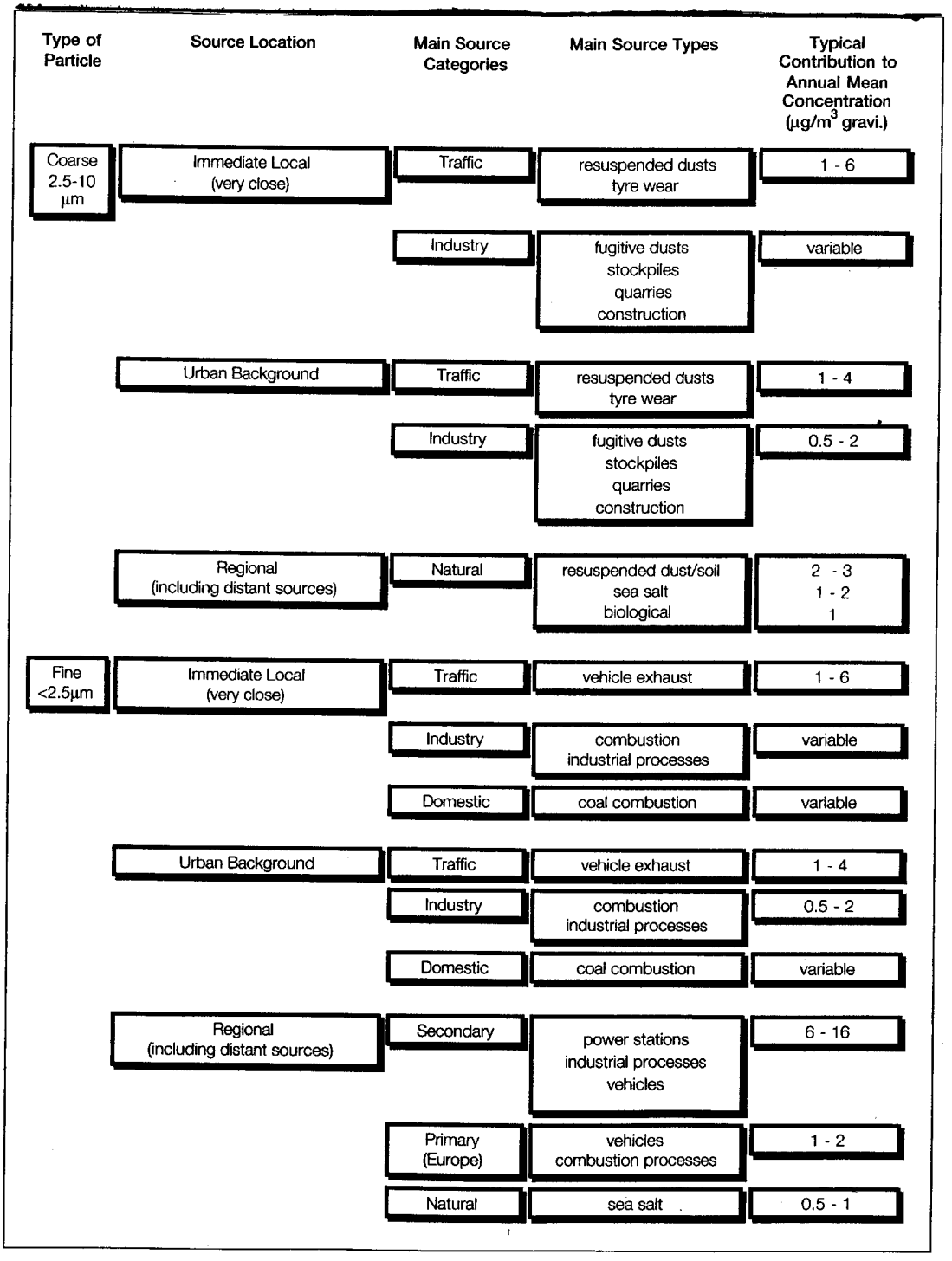


Type of Particle	Source Location	Main Source Categories	Main Source Types	Typical Contribution to Annual Mean Concentration ($\mu g/m^3$ gravi.)
Coarse 2.5-10 µm	Immediate Local (very close)	Traffic	resuspended dusts tyre wear	1 - 6
		Industry	fugitive dusts stockpiles quarries construction	variable
	Urban Background	Traffic	resuspended dusts tyre wear	1 - 4
		Industry	fugitive dusts stockpiles quarries construction	0.5 - 2
	Regional (including distant sources)	Natural	resuspended dust/soil sea salt biological	2 - 3 1 - 2 1
Fine <2.5µm	Immediate Local (very close)	Traffic	vehicle exhaust	1 - 6
		Industry	combustion industrial processes	variable
		Domestic	coal combustion	variable
	Urban Background	Traffic	vehicle exhaust	1 - 4
		Industry	combustion industrial processes	0.5 - 2
		Domestic	coal combustion	variable
	Regional (including distant sources)	Secondary	power stations industrial processes vehicles	6 - 16
		Primary (Europe)	vehicles combustion processes	1 - 2
		Natural	sea salt	0.5 - 1

PM_{10} data from monitoring sites within the Automatic Urban and Rural Networks indicates that the proposed annual mean objective 40 µg/m^3, (gravimetric) is estimated to have been met at all sites in 1997, with the exception of a kerbside side in London (Camden Roadside), which exceeded by less than 2 µg/m^3. The 24-hour objective (50 µg/m^3, (gravimetric), maximum of 35 exceedances per year)) is estimated to have been exceeded at most of the roadside/kerbside sites, and exceeded or closely approached at about 30% of urban and suburban locations. Concentrations at rural/remote sites were well below the objective. The 24-hour mean objective is more stringent than the annual mean objective (TG4(00) - DETR, 2000)[xxx].

It is confidently expected that PM_{10} concentrations will have fallen by the end of 2004, when the objectives are to be met. An analysis of PM_{10} projections for 2004 is presented in the Air Quality Strategy (DETR, 2000)[2]. The analysis was carried out using both 1995 and 1996 monitoring data, because 1996 was characterised by a much higher frequency of easterly winds associated with the transport of polluted air from mainland Europe to the UK. The 1996 meteorology occurs about once every five to 10 years and may therefore be described as 'atypical' and as such represents a worst-case, pessimistic scenario upon which to base predictions of future PM_{10} concentrations. The analysis has indicated that with existing national policy measures and atypical meteorology, exceedances of the objectives might be found in the following areas:-

- urban background sites in central London;
- areas adjacent to busy roads, particularly within major urban areas;
- areas which have significant emissions from the domestic burning of solid fuels;
- areas in the vicinity of industrial plant, or which have significant uncontrolled or fugitive emissions (for example quarrying, materials handling facilities etc).

Such areas are expected to form the focus of more detailed review and assessment for Local Authorities. It is considered unlikely that the objectives will be exceeded at locations other than those listed above. It is not anticipated that Local Authorities will generally need to proceed beyond the first stage review and assessment in other areas other than those listed above.

14.1.4 Measurement of PM_{10}

Gravimetric vs TEOM measurement data

Monitoring of PM_{10} levels in the UK has, to date, been largely based upon the use of TEOM analysers. A principal concern with the TEOM instrument is that the filter is held at an elevated temperature (50^{0}C) in order to minimise errors associated with the evaporation and condensation of water vapour. This can lead to the loss of the more volatile species (some hydrocarbons, nitrates etc) and has led to the identification of differences between TEOM and gravimetric measurements at co-located sites. Gravimetric instruments also have the potential to lose some volatile particles, especially ammonium nitrate, the proportion of which is dependent upon the history of the sample.

The recently published Airborne Particles Expert Group (APEG) report[27] concluded that at concentrations around 50 µg/m^3 the TEOM tends to under-read compared with a gravimetric sampler by between 15 and 30%. However, this effect is not constant, and varies depending upon the mass concentration, the distance from a specific source, and the environmental conditions. Further studies have been commissioned by DETR to investigate these effects, and to provide a more robust relationship between the TEOM and the European transfer gravimetric reference method.

The air quality objectives are based upon measurements carried out using the European transfer reference method or equivalent. There is therefore a potential inconsistency between measurements of PM_{10} concentrations made using a TEOM analyser and the objectives - for example, a daily mean concentration of 45 µg/m^3 measured using a TEOM analyser could be

underestimating the 'gravimetric' concentration by 15 µg/m^3 or more. It is therefore necessary to apply a 'correction factor' when assessing TEOM measured concentrations against the objectives. For the purpose of this report, a constant factor of 1.3 has been used (consistent with the APEG report) and is applied to all TEOM measured concentrations. For example, a TEOM concentration of 20 µg/m^3 is expressed as 20 x 1.3 = 26 µg/m^3, gravimetric. To make this clear, all data are expressed as [µg/m^3, TEOM] or [µg/m^3, gravimetric] as appropriate.

14.1.5 Principal Sources of PM_{10} within the Borough

14.1.5.1 Industrial

As can be seen from Appendix 1 and correspondence with the Environment Agency [8], there are two existing authorised Part A processes which may give rise to significant emissions of particulates. It should be noted that the significance of emissions relates to total particulates and PM_{10} emissions are presently unknown. Processes and locations are as follows:-

1 British Sugar, Wissington.

2 Porvair International, Estuary Road, King's Lynn - Petrochemical Processing and Associated Plant.

There are four Part B authorised processes which may give rise to potential significant emissions of PM_{10}s. These are:-

1 Associated British Ports, King's Lynn - Coal handling (Note: coal has not been handled in the port for several years although an authorisation is current).

2 Sibelco Minerals and Chemicals, Leziate - sand drying and screening.

3 RMC Roadstone, Bentinck Dock, King's Lynn - roadstone coating.

4 Tarmac Heavy Building Products Limited, Pentney - roadstone coating.

The DETR - TG4(00) (2000)[3] have not indicated any other Part B processes which may give rise to significant PM_{10} emissions. There are five animal feed plants which are also authorised under the Part B Environmental Protection Act 1990 which bear some further consideration despite this guidance.

14.1.5.2 Other Sources including Quarries and Landfill Sites

There are several other locations in the Borough which bear further consideration in relation to PM_{10} emissions. These are as follows:

1 **King's Lynn Port area** - the bulk handling of cargoes in the Port area which includes wheat, soya, roadstone, etc, may give rise to emissions which are presently uncharacterised. In addition this area has two prescribed processes namely coal handling and roadstone coating which are highlighted as potential significant emitters above.

2 **One non-prescribed coal fired boiler** has been identified in the King's Lynn Urban area which contributes an unknown quantity of PM_{10}.

3 **Quarries** - there are 12 mineral extraction areas within the Borough mainly for sand/gravel but also lesser workings of carrstone and chalk.

4 **Landfill sites** - there are six areas within the Borough where significant landfilling/waste disposal occurs. Several of the sites are combined with quarrying activity.

In the case of uncharacterised sources such as quarries and landfill sites, given a 2004 background concentration of <25 μg/m^3 (gravimetric) further consideration is only given where properties are less than 200 m from the source.

14.1.5.3 **Road Transport**

The potential significance of PM_{10} emissions from road traffic is dependent upon a number of factors including the background concentration (for 2004), and traffic conditions such as the traffic flow, speed and HGV mix. The impact of traffic emissions falls off rapidly with increasing distance from the kerbside, and it is also important to take account of the likelihood of regular public exposure in locations such as residential accommodation.

TG4(00) (DETR 2000)[3] has indicated where there are one or more existing or planned roads with a projected annual average traffic flow of greater than 5000 vehicles/day in 2004 then further consideration may have to be given to this source (depending on certain criteria below). As can be seen from Table 5 there are a number roads exceeding this traffic flow both presently and in 2004. Where the HGV proportion exceeds 12%, there are property facades within 100 m and traffic flows exceed 5000 AADT then a second/third stage review and assessment is required.

Similarly where the HGV proportion is less than 12%, there is a single carriageway road and receptor locations within 2 m of kerbside then a second/third stage is appropriate (given a maximum projected background concentration PM_{10} 24 μg/m^3) where AADT exceeds a minimum of 20000.

Given that there are a number of roads fulfilling this criteria, a Stage 2/3 assessment is appropriate for road traffic sources.

14.1.5.4 **Natural Sources**

The rural areas of the Borough are characterised by large open arable fields. Relatively flat, open nature of the land allows soil and dust to be readily picked up by the wind. The local contribution from such sources is presently unknown. Sea salt is also likely to be a significant natural source although the contribution again is presently unknown.

14.1.5.5 **Emissions from domestic and other low level dispersed sources**

DETR (00)[3] suggests that if the density of people in coal burning households per km^2 is known then a decision as to whether further assessment is necessary can be made. This matter is considered further in the Stage 2 review and assessment.

14.1.5.6 **Sources outside the Borough**

Apart from the transboundary nature of this pollutant, and its contribution to local concentrations, one potential significant source has been identified just outside the Borough. This is a large coal fired steam/heat raising plant in the area of Fenland DC in Wisbech. (For more details see Section 15.5).

14.1.6 Monitoring and Background Concentrations

The Borough Council is presently undertaking PM_{10} monitoring at two locations utilising R & P TEOM equipment and Turnkey Osiris monitors. Monitoring began in April 1999. Results of this monitoring will be considered in detail in Section 14.2.2.1.

The DETR Worldwide Web Site indicated in 1996 in the King's Lynn area the annual mean regional background due to secondary particles was 14 to 15 $\mu g/m^3$. It is believed that national policies will see a reduction in the emission of sulphur dioxide and nitrogen oxide which in turn will see reduced concentrations of secondary particles. By 2005 it is believed the concentration of secondary particles will be 0.7 x the 1996 figure. Secondary particles have a significant trans-boundary content.

In terms of particulate background concentrations in the UK in 1996 the worldwide web indicates that for the Borough the concentration ranged from 22.6 to 25 $\mu g/m^3$. This includes the secondary particulate component detailed above. In 2004 the projected background concentrations range from 22.5 $\mu g/m^3$ to 23.4 $\mu g/m^3$ with the average about 22.7 $\mu g/m^3$.

14.1.7 Future Developments

There are proposals for comparitively large scale development in the so-called Nar-Ouse regeneration area. It is not known the extent of PM_{10} emissions during development and review and assessment may be required when more information becomes available. This matter will be addressed in the Borough's Air Quality Strategy.

14.1.8 Assessment for PM_{10}

A number of Part A and Part B authorised point sources and some other industrial plant have been identified which potentially could give rise to significant emissions of PM_{10}. Furthermore, there is some uncertainty regarding the significance of emissions from a number of sources. It is recognised that further consideration is necessary for this pollutant for the following reasons:

- there are one or more existing or planned roads with traffic flows above DETR guidance levels;
- there are one or more Part A or B processes of the type indicated to be potential significant sources of PM_{10};
- there are uncharacterised sources such as quarries and landfill sites with properties less than 200 m distance, given a 2004 background concentration of <25 $\mu g/m^3$ (gravimetric).

On the basis of the information obtained above it cannot be assumed the risk of exceeding the objective for PM_{10} in relevant locations is negligible. It is therefore recommended that the Authority proceeds to the second and where appropriate the third stage of the review in assessment for this pollutant.

14.2 SECOND STAGE REVIEW AND ASSESSMENT OF FINE PARTICLES (PM_{10})

14.2.1 Sources within the Borough

As indicated in 14.1.5 above there are a number of potentially significant sources of PM_{10} within the Borough which bear further consideration.

14.2.1.1 **Industrial** - as noted in Section 14.1 there were two potentially significant emitters of PM_{10} identified by the 1st stage review and assessment authorised under Part A by the Environment Agency namely;

1 British Sugar, Wissington - CHP plant.
2 Porvair International

Other potentially significant sources administered under LAAPC identified were:

1 Associated British Ports, King's Lynn.
2 Sibelco Minerals and Chemicals, Leziate.
3 RMC Roadstone, Bentinck Dock, King's Lynn.
4 Tarmac Heavy Building Products Limited, Pentney.

Although not indicated by TG4(00) (DETR2000)[3] discussion with the DETR helpline indicates that five animal feed plants which emit particulate matter and are authorised under Pt B EPA 1990 bear some further consideration.

14.2.1.2 **Other sources including quarries and landfill sites**

These sources were detailed in Section 14.1.5.2 as follows:-

1 King's Lynn Port area.
2 A non-prescribed coal fired boiler plant located at Del Monte, West Lynn.
3 Quarries - twelve areas.
4 Landfill sites - six areas.

14.2.1.3 **Road transport** - there are a number of roads which bear further consideration at this stage and the assessment is outlined below.

14.2.1.4 **Domestic and other low level dispersed sources**

This matter is considered below.

14.2.1.5 **Monitoring in the King's Lynn area**

As noted in Section 14.2.2.1 the Borough Council has undertaken PM_{10} monitoring in the locality since April 1999 using a R & P TEOM analyser.

Initially monitoring was sited at a roadside location near the Southgates in King's Lynn town centre and then in August 2000 the equipment was transferred to an industrial sand drying facility at Leziate, a small village several miles from King's Lynn.

The charted results from this monitoring is enclosed as Figs 14 and 15. A summary of monitoring is shown below in Table 19.

Table 19 – monitored PM_{10} concentrations at Southgates Park, King's Lynn

Location and Date	PM_{10} concentration, gravimetric ($\mu g/m^3$)			
	Annual Mean		90.14 on Percentile of 24 hour means	
	Measured	Objectives For 1.1.05	Max Measured 24 hour mean	Objective For 1.1.05
Southgates Park King's Lynn 1.4.99 to 31.3.2000	20.8	40	57.2 (1 exceedance)	50 (35 exceedances per year)
Southgates Park 1.4.00 to 31.8.00	16.9	40	49.4	50

The above data has been ratified according to procedures outlined in Section 13.2.4.3 by AEA Technology Plc and therefore the data can be reported with confidence. The concentrations recorded indicate annual mean PM_{10} concentrations significantly below the objective for 1 January 2005 of 40 $\mu g/m^3$ gravimetric. Similarly there was only 1 exceedance of the 24 hour mean standard of 50 $\mu g/m^3$ gravimetric with an objective of no more than 35 exceedances per year by 1 January 2005.

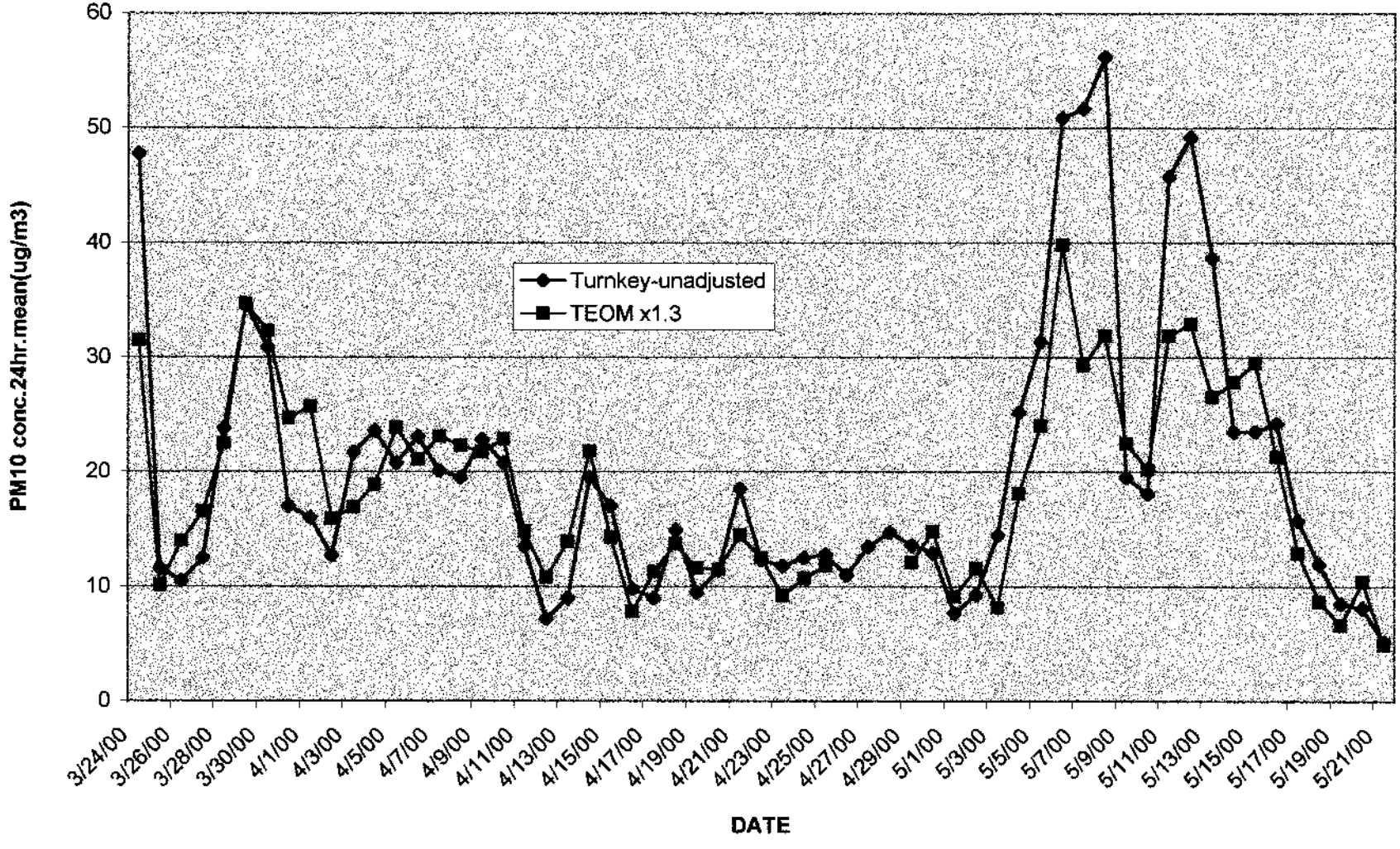
Thus it appears even beside a major road in King's Lynn the PM_{10} objective currently is comfortably met. (Also see Section 14.2.2.3).

North Lynn – in August 2000 another monitoring site was established on the fringe of King's Lynn dock area between Edward Benefer Way and St Edmundsbury Road in suburban King's Lynn. The purpose of this site was to monitor PM_{10} emissions from the nearby docks area. In the period 1 August 2000 to 31 December 2000 no exceedances of the 90.14 percentile of 24 hour mean objective for 1 January 2005 of 50 $\mu g/m^3$ gravimetric was recorded. The maximum 24 hour average PM_{10} concentration recorded was 44.2 $\mu g/m^3$,gravimetric and the mean 23.73 $\mu g/m^{3.}$ The annual mean objective to be achieved by 1 January 2005 is 40 $\mu g/m^3$. It should be acknowledged that ratified data is only presently available for August/September 2000. Thereafter the data is provisional. However examination of the data set does not suggest the ratified data will significantly differ from the provisional and the objective for 2005 does not appear to be clearly at risk. This provisional conclusion would be confirmed by longer term monitoring. The charted data is presented in Appendix 8.

Table 20 - PM_{10} at North Lynn

Location and Date	PM_{10} concentration, gravimetric ($\mu g/m^3$)			
	Annual Mean		90.14 on Percentile of 24 hour mean	
	Measured	Objectives For 1.1.05	Max Measured 24 hour mean	Objective For 1.1.05
North Lynn Monitoring site 1.8.00 to 31.12.00	23.73	40	44.2	50 (no more than 35 exceedances)

Fig.20 Comparison of 24hr.mean PM10 concentration measurements by Turnkey & TEOM (ug/m3)-London Rd,Southgates,King's Lynn



Turnkey Osiris monitoring

This instrument is a small portable monitor able to measure PM_{10} which can be mounted on a lamp post to be used as a 'screening' tool. An Osiris was co-located with the R & P TEOM at the Southgates site to establish whether similar measured levels of PM_{10} were recorded. Results indicate over the period 24 March 2000 to 21 May 2000 a reasonable correlation between the two instruments (r = 0.866). This can be viewed in Fig 20. The mean concentrations measured over the same period were 20.05 $\mu g/m^3$ by the Osiris and 18.64 $\mu g/m^3$, gravimetric by the TEOM. It is apparent that the Osiris appears to over read the TEOM at higher concentrations. The Osiris therefore has some value as an indicative 'screening' instrument. The instrument is subject to flow checks, three monthly servicing and calibration against an unheated TEOM by the supplier.

Regional modelling and monitoring of PM_{10}

In 1999 the Borough Council joined other Norfolk Authorities in part-funding a collaborative project with the University of East Anglia to investigate the relative contribution of local and distant sources of particulates to Eastern England. The work was published in December 2000 (Chatterton 2000)[36]. As part of the project PM_{10} monitoring was undertaken at Stoke Ferry in the south of the Borough and compared with PM_{10} monitoring results from sites in Norwich and King's Lynn. The full report will be available on the internet although a copy is available at the Borough Council offices.

In particular in the period April 1999 to March 2000 the average difference in daily mean values between King's Lynn Southgates site and a site in central Norwich was less than 3 $\mu g/m^3$.

The study appears to show a number of points (after Chatterton 2000)[36]:-

- levels of PM_{10} in Norfolk appear to show very little difference between rural areas and urban areas (just over 2 $\mu g/m^3$ over a six month period)
- over a daily averaging period PM_{10} showed a little over 1$\mu g/m^3$ difference between a background site in Norwich and a busy street with a large proportion of diesel vehicles and frequent congestion
- sulphate, the major constituent of secondary PM_{10} as monitored by TEOMS comprises around 15 – 30% of rural background PM_{10} [TEOM] although this is expected to increase significantly during sulphate episodes
- coarse particulates appear to be very significant (if not dominant) fraction of PM_{10}.

14.2.1.6 **Determination of 2004 Background PM_{10} Concentrations**

TG4(00) (DETR 2000)[3] lays down a methodology for calculating the background PM_{10} concentrations using local monitoring data. Paragraphs 8.50 and 8.56 noted the potential for the calculation of negative primary concentrations. As the calculated concentration was indeed negative at the Southgates road side monitoring site for 1999 (primary concentration – 3.74 $\mu g/m^3$), it was decided to utilise background PM_{10} concentrations for 2004 from the internet as these were considered more suitable. In 2004 the estimated background concentrations range from 22.5 $\mu g/m^3$ to 23.4ug/m across the Borough.

14.2.2 **Assessment for Fine Particles**

14.2.2.1 **Industrial**

1 **British Sugar, Wissington** - the CHP plant has authorisation for the burning of gas as the main fuel and gas oil with a sulphur content of 0.2% as a standby fuel. Given the nature of the fuel burnt on this plant it is unlikely that there is a risk of the air quality standard and objective being exceeded.

As regards the Part B LAAPC animal feed authorisation, this process involves the drying of sugar beet residues for the purpose of manufacturing animal feed. Emission testing results of total particulate emissions (as opposed to PM_{10}) has been carried out for a number of years. The animal feed drying process only operates for approximately 6 months of each year.

During this period the plant operates 24 hours per day continuously. The measured total particulate mass emission ranges from about 25 tonnes/6 months to 51 tonnes per annum should the emission rate be doubled assuming a continuous emissions over a year. This mass emission has been arrived at by utilising the highest emission test result in the recent past.

Monitoring undertaken by British Sugar [28] from one sampling exercise indicates that approximately 30% of the emissions are of PM_{10} size and below. This work is indicative as only one exercise is involved.

Assessment for British Sugar

Utilising the methodology in TG4(00) (DETR 2000)[3] the effective stack height is 0m as there are buildings taller than the 45.75m stack within 5 actual stack heights distance. Due to the building heights and configurations, stack velocity etc the GSS methodology (Environment Agency, 1998)[12a] is not strictly applicable to assessment of this source. The plant is located in a sparsely populated rural area and the nearest residential property is about 1.2km from the plant. It is unlikely that members of the public will be regularly present over the averaging period of the objective closer to the plant. Nevertheless, given the information available it was appropriate to undertake further work by running an advanced air dispersion model in co-operation with the company. Accordingly the Borough Council commissioned Consultants (CERC) to undertake an air dispersion modelling exercise using ADMS3. This exercise has been previously described in Section 13.2.8.1. Bearing in mind the comparitive remoteness of the plant and the potential for public exposure it is not thought realistic that locations where leisure activities could occur were relevant. TG4(00) (DETR 2000)[3] states 'for the purposes of determining the focus of review and assessment, local authorities should have regard to those locations where members of the public are likely to be regularly present and are likely to be exposed over the averaging period of the objective. Authorities should not consider exceedances of the objectives at any location where relevant public exposure would not be realistic! Residential properties were therefore viewed as relevant locations'.

The modelling undertaken utilised the worst case total particulate measurements over the last four years of emission monitoring and other emission factors as previously described.

Results – the full air dispersion monitoring report is enclosed within the Technical annex. At the nearest residential properties the modelled PM_{10} concentrations are shown below in Table 21 (see Fig 6 for relevant receptor locations).

Table 21 Predicted PM concentrations from British Sugar, Wissington annual mean and 90.14 percentiles of 24 hour mean (μg/m^3) including background

Location and Date	PM concentration, gravimetric (μg/m^3)			
	Gas Firing		Oil Firing	
	90.14 percentile of 24 hour mean	Annual Mean	90.14 percentile of 24 hour mean	Annual Mean
Point 2	32	25	34	25
Point 4	27	24	28	25
Point 5	28	25	29	25
Maximum	109	36	128	38

NOTE - the 90.14 percentile of 24 hour mean is a standard of 50 μg/m^3 with an objective of no more than 35 exceedances by 1 January 2005

- the annual mean objective is 40 μg/m^3 to be achieved by 1 January 2005. As noted previously the modelling has assumed that 100% of particulate matter is in the form of PM_{10}. Given the above there are no predicted exceedances of the objectives at relevant locations. It is acknowledged that at non-relevant locations within 500 m to the north of the sugar factory the predicted 90.14 percentiles of 24 hour mean concentrations of particulate matter could exceed the objective levels for both gas and oil firing. It should be noted however that modelling assumes all PM is PM_{10} and that the animal feed dryers operate throughout the year which is not the case.

  Given the above it is not considered that there is a significant risk of the objectives being exceeded at relevant locations.
  Traffic in the direct locality is less than 3000 AADT and it is not thought that such emissions are likely to be of significance in combination with point source emissions.

2 **Porvair International, King's Lynn** - in the recent past coal fired boilers have been replaced by gas fired with standby usage of gas oil.

There are two small heavy fuel oil fired boilers still remaining in use (2.3MW and 1.7MW rating) but these are not thought to be of significance in terms of PM_{10} emissions neither are the gas or gas oil fired boiler plant.

Consequently it is not considered that there is a significant risk of the objective being exceeded now or in the future from this source.

3 **Associated British Ports, King's Lynn** - no coal has been handled for several years so it is not possible to assess emissions. As part of an Air Quality Strategy it would be appropriate to assess this potential source should the situation change.

4 **Sibelco Minerals and Chemicals, Leziate** - this facility consists of a comparatively large industrial undertaking which processes quarried sand for the purposes of glassmaking and foundries. Due to the topography, building configurations, multiple stacks and heights the GSS methodology produced by the Environment Agency (1998)[12a] was not applicable to the assessment of this source. Consequently an advanced air dispersion modelling exercise was commissioned from Cambridge Environmental Research Consultants (CERC). Emission monitoring data was reviewed and realistic emission inputs utilised along with site factors. 5 stacks were modelled. The modelling predicted potential exceedances of the standard on site but not at locations where members of the public could be regularly exposed (ie residential houses and gardens). Four relevant locations were modelled off site and at those locations, with typical operating conditions, the maximum predicted process contribution to the 90.14th percentile of 24 hourly mean was predicted to be 5 ug/m^3 (PM) and 2 ug/m^3 to the annual mean. CERC have reported that even taking into account a background PM_{10} concentration of 24 ug/m^3, there are no exceedances of the AQ's objectives predicted at any of the four residential properties

Modelling assumed that all measured particulate matter was PM_{10}, all 5 stacks emitted continuously and simultaneously. In actuality the maximum plant running times are 70 hours per week, simultaneous operation does not always occur and emitted particles are not 100% PM_{10}. This has been confirmed by particle size analysis undertaken in co-operation with the company. For this reason the modelling was viewed as a worst case scenario. For details of modelling see Technical annex. Consequently it is not considered that there is a significant risk of the objective being exceeded from stack emissions at the site. However, fugitive emissions have been identified as potentially affecting residential properties principally due to lorry movements via a haul road and turning area at the entrance to the plant. No complaints have been made to the department regarding dust nuisance from residents. Fugitive emissions from main plant activities are not considered likely to affect local residents due to the separation distances (>200m) and the projected 2004 background PM_{10} concentration is 22.8 ug/m^3 (Note - according to DETR Guidance TG4(00) (2000) if the estimated annual mean PM_{10} concentration is below 25ug/m^3 gravimetric and there are no public exposure locations closer than 200m then there is no need to proceed further).

Given the situation outlined above as regards fugitive emissions, monitoring was commenced in September 2000 to try and assess the impact of lorry movements on PM_{10} concentrations. The monitoring station was sited adjacent to the nearest relevant location to the main plant. This property was a relevant location in the modelling exercise. Results to date (31.12.00) have indicated three exceedances of the 50ug/m^3 24 hour standard and are summarised in Table 22. Charted Outputs are shown in Appendix 8a. Examining meteorological data indicates that PM_{10} levels were closely associated with lorry movements and dry weather. It is worth noting that measurements were taken by a TEOM. Results have been converted to gravimetric by multiplying by 1.3. In this situation it is likely that most of the PM_{10} emissions are expected to be silicon based materials rather than volatiles. This would tend to suggest measurements are conservative by being converted to the gravimetric metric.

Table 22 - Summary of monitored PM_{10} concentrations at Leziate (ug/m^3, gravimetric)

Location	**PM_{10} concentrations (ug/m^3, gravimetric)**			
	Measured mean concentration (ug/$m^{3)}$	Annual mean objective for 1.1.05 (ug/$m^{3)}$	Measured Maximum 24 hour mean concentration (ug/m^3)	90.14th percentile of 24 hour mean concentration (ug/m^3) standard
Leziate	19.18	6.40	76.7	50

NOTE: - mean date capture 98%
- data from 1.10.00 not ratified at present
- in four months of monitoring there have been 3 different exceedances of the 24 hour mean standard. The objective is no more than 35 exceedances per calendar year.

The company have provided written confirmation that dust generating areas are being addressed and the company are actively pursuing transferring further transport operations from road to rail. As the process is subject to LAAPC control, review of the authorisation will make control measures mandatory and progress will be reviewed as part of the Air Quality Strategy. Consequently it is not considered that there is a significant risk of the air quality standard and objective being exceeded from this facility.

5 **RMC Roadstone, Bentinck Dock, King's Lynn** - this plant produces roadstone from aggregates imported by ship. The plant consists of a mixing and coating area and stockpiles in outlying locations. The main plant activities are located in excess of 200m from the nearest adjacent residential property although some stockpiles are located closer than this distance. There have been no nuisance dust complaints from the site, although other dock activities have generated occasional complaints. As part of the process roadstone is heated and screened and then mixed with hot bitumen. According to DETR TG4(00) (2000) such operations are potentially significant emitters of fine particles, PM_{10}. Accordingly emissions from the 23m stack have been assessed utilising an advanced air dispersion model as the GSS methodology produced by the Environment Agency (1998) was not appropriate. Modelling was undertaken by Cambridge Environmental Research Consultants (CERC) utilising ADMS-3 and included projected emissions from the A1078 road in 2004. The background PM_{10} concentration projected for 2004 is 23.1 ug/m^3, gravimetric although for the purposes of modelling it was presumed to be 24 ug/m^3, gravimetric. The modelling indicates that even after the background concentration is taken into account, the predicted concentrations are well below the standard and objective values. The modelling exercise was conservative in that the worst case emission inputs were utilised and it is assumed that the emission is continuous. The plant typically operates for about 40 hours per week. A summary of predicted modelled concentrations is shown in Table 23. (Note - for modelling see technical annex).

Table 23. Maximum Predicted Concentrations of PM (µg/m^3) - RMC Roadstone, Bentinck Dock, King's Lynn

	90.14th Percentile of 24 Hour Means			Annual Mean		
	Predicted	**Standard**	**% of Standard**	**Predicted**	**Standard**	**% of Standard**
Process Contribution	4.8 (4.7)	50	10	1.6 (1.5)	40	4
Process Contribution and Background	28.8	50	58	25.6	40	64
Location	562000 321300			526000 321300		

As regards fugitive emissions, the nearest existing and future residential properties are at about 140 to 180 m distance from stockpiles. Due to the nature of the activities and intervening topography it is considered that there is not a significant risk of the standard and objective being exceeded from this source. Furthermore, since August 2000 monitoring has been undertaken at a location about 180 m from the nearest aggregate stockpile on the docks and about 350 m from the roadstone plant stack. This is also the location where the maximum 90.14th percentile of 24 hour mean and annual mean concentrations of PM_{10} are predicted from the roadstone coating plant stack at locations where there is likely to be public exposure. It is also downwind of prevailing winds blowing across the site. Examination of meteorological data for the period 1981 - 1990 from RAF Marham (the nearest recognised met station) indicates that from direction 166^0 to 255^0 (SSE to WSW), winds blow from this direction for about 38% of the time. To date monitoring has not shown any exceedances of the standard and objective. The maximum 24 hour mean PM_{10} concentration recorded was 34 ug/m^3, TEOM which is equivalent to 44.2 ug/m^3, gravimetric, against a standard of 50ug/m^3, gravimetric. The annual mean over the period was 18.25 ug/m^3 TEOM which is equivalent to 23.73 ug/m^3, gravimetric, against an annual mean objective of 40 ug/m^3 to be achieved by 1.1.05. During the period of monitoring there were several dry periods. A summary of monitoring is enclosed at Table 20 and charted outputs within Appendix 8. Data ratification covers the period August/September 2000 thereafter data is provisional. Nevertheless it is not expected that ratified data sets will significantly differ from the provisional. Monitoring is continuing which will provide additional confidence in the conclusion that there does not appear to be a significant risk of the standards and objectives being exceeded from emissions from the roadstone coating plant and general docks activities at this location. Continued monitoring would reinforce this conclusion.

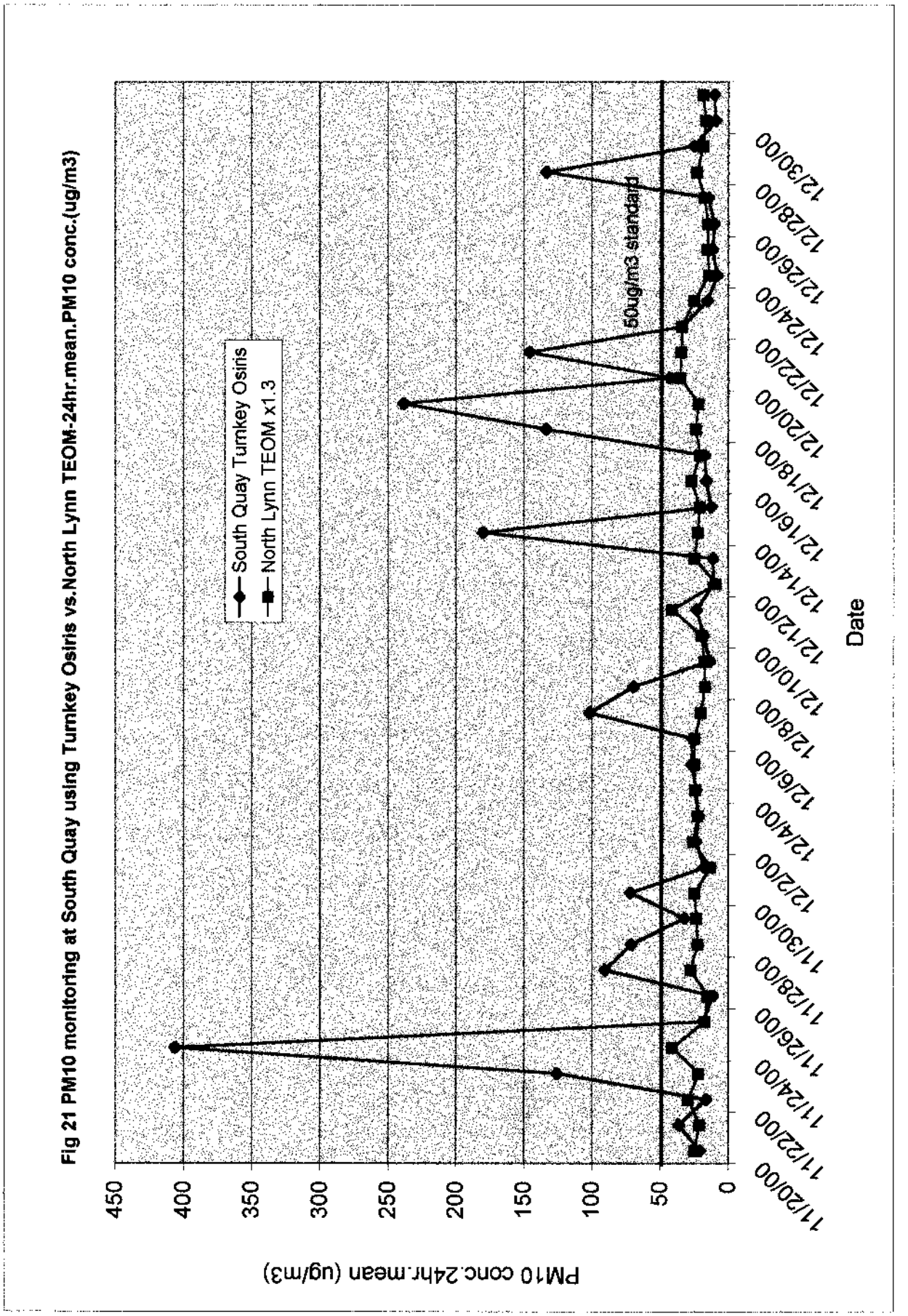


Fig 21 PM10 monitoring at South Quay using Turnkey Osiris vs.North Lynn TEOM-24hr.mean.PM10 conc.(ug/m3)

6 **Tarmac Heavy Building Products Limited, Pentney** - this plant consists of a roadstone coating plant, associated aggregate stockpiles and handling facilities. The nearest residential property is estimated to be approximately 1km from the main site activities. The plant is served by bag filtration and a 23 m stack. The area is rural with sparse population and no busy roads. From monitoring data and operating conditions it is estimated that the mass emission is less than 1 tonne per annum total particulate matter, from the stack. Given an effective stack height of 23 m and the calculated emission rate, utilisation of DETR technical guidance (2000) indicates that a concentration of 1ug/m^3 90th percentile of 24 hour means will not be reached which is the threshold for undertaking more detailed work. It is not considered therefore that there is significant risk of the standard and objective being exceeded from this source.

7 **Animal Feed Compounding Processes**

As mentioned in 14.2.1.2 it appears to be appropriate to undertake some further work in order to try and characterise and assess the significance of emissions from these sources. Emissions chiefly consist of particulate matter of organic origin arising from the manufacturing of animal feed stuffs. Consideration of mass emissions suggests that due to comparatively low concentrations and limited operation of the processes that they may not be of major significance. Nevertheless it was considered appropriate following contact with the DETR helpdesk[35] that some further work was appropriate.

Favor Parker, Stoke Ferry – this plant is located in a village centre in a rural location. Relevant locations in the form of housing are situated in excess of 50m from emission points. Available monitoring data indicates a mass emission of about 9.3 tonnes/yr from the plant of total particulates. A total of 8 emission points are located at about 17m above ground level. The building arrangements are complex. Due to the number of emission points and the building arrangements, it was considered appropriate to undertake an advanced air dispersion modelling exercise to determine ground level concentrations at relevant locations in relation to the air quality objectives. The methodologies in DETR TG4 (00) and GSS (Environment Agency, 1998)[12a] were not applicable to this source. The modelling exercise was undertaken by CERC using ADMS 3, the results of which are available in Appendix 12. Two model runs were undertaken, the first with outlets at current heights and the other where raised between 2 and 4m. At relevant locations there were no predicted exceedances of the objectives although at the existing heights there was a predicted exceedance of the 90.14th percentile 24 hr. mean concentration objective close to the plant buildings. It should be recognised that the modelling was undertaken assuming all PM was PM_{10} which is unlikely to be the case. Furthermore modelling also assumed that the plant runs continuously throughout the year when it runs for about 45 weeks. Nevertheless to gain additional confidence in ensuring the objectives are achieved, the operator and the Borough are presently reviewing outlet heights and emission character as part of the review of the authorisation if necessary to raise outlet heights to improve dispersion.

Scott Nutrition, Southery – this authorised process is located in a remote rural area on the Fens although there is a residential property located on the site at about 60m distant. Monitoring data indicates a mass emission of total PM of about 1.83 tonnes/yr from 3 emission points. Given outlet heights of 27m and utilising the methodology laid down in TG4 (00), up to 6.48 tonnes/yr of PM_{10} could be emitted to give a 90.14th percentile of 24hr. mean concentration of 1ug/m^3. (Given a background annual mean PM10 concentration estimated for 2004 of 22.6ug/m^3). It is therefore not considered that emissions from this plant are significant.

Bernard Matthews Feed Mill, Bawsey – this authorised process is located in a primarily rural area with the nearest relevant location about 110m distant.

Available monitoring data indicates mass emissions of total PM of about 1.2 tonnes/yr. This plant is presently undergoing extensive alterations and no current emissions data is available although it is anticipated that emissions will decrease. Given the discharge height (> 13m), volumetric flow rates of emissions, locality and distance to relevant locations it is not thought that the emissions will be significant in relation to the air quality objectives although further assessment will be undertaken as part of the review of the authorisation.

Beart, Stowbridge – this comparatively small authorised process is located in a rural village. There are no significant discharges to the atmosphere from this plant.

Given the above, it is not considered that there is a significant risk of the objectives being exceeded at relevant locations from animal feed plant emissions in the Borough.

14.2.2.2 **Other Sources**

1 **King's Lynn Port Area**

The main activities at this location are roadstone coating and the associated storage of minerals (see Section 14.2.2.1), the loading of scrap metal, the loading/unloading of cereals, animal feeds, timber and miscellaneous cargos.

Section 14.2.2.1 considered the roadstone coating operations. Scrap metal activities occur in excess of 200 m from the nearest residential properties. Cereal loading/unloading occurs less than 200 m from a newly approved development including domestic properties. Such activities have not been highlighted by the DETR as being significant fine particle emitters in TG4(00) (2000) nor are they prescribed processes under the Environmental Protection (Prescribed Processes and Substances) Regulations 1991 (as amended). Subjective evidence suggests that visible emissions in the locality of the development are not prevalent. It should be acknowledged that current residential development is in the region of 200 m from existing activities and sporadic complaint has been received. As detailed in 14.2.2.1 winds from directions 166^0 to 255^0 typically blow towards the locality for about 38% of the time. Ships load/unload cereal/animal feed at adjacent berths approximately four times per month presently according to the Port Management[37]. It has not been possible to monitor this location within the time period for allowed for Review and Assessment and monitoring will commence by January 2001. It is not thought that there is a significant risk of exceeding the objective at this location although it will be part of the Borough's Air Quality Strategy to review this location on an ongoing basis. The remainder of sources associated with loading/unloading on the port are not thought to be significant due to the nature of the activity and/or the distances from residential development.

2 **South Quay**

In this area a cereal loading quay is sited which has been the subject of a number of complaints over the recent past. Residential facades are located within about 40 m of the loading operations. The locality can be described as an 'open area' beside the River Ouse. Visible emissions are common in the locality. According to the owners the quay typically services about 25 vessels per year, each taking typically 1½ days to load. Mid-Summer is the busiest period.

From November 2000 indicative monitoring has been carried out using a Turnkey Osiris Monitor. This has indicated 12 possible exceedances of the 24 hour mean PM10 standard of 50ug/m3 over a 43 day period. It is believed

that the cause is a local source and probably cereal loading operations. The results of the monitoring are presented graphically in Figure 21. A comparison with concurrent PM_{10} monitoring at North Lynn is shown. It is intended to move an R and P TEOM to the locality by the end of January 2001 to establish whether or not there is a significant issue of PM10 emissions in this locality.

On the basis of the information available there appears to be a possible significant risk of the objectives being exceeded at this location - Consequently a more detailed consideration of this location is appropriate.

3 **Coal Fired Boiler Plant at Del Monte, West Lynn**

As is detailed in 15.2.2.4.1 this facility consists of two coal fired boilers which operate alternately when the plant is operating.

Methodology - in order to gain an insight into the operating variables of the boilers, monitoring was undertaken for coal feed rate, air flow rate, flue gas temperature, etc over a 24 hour period. The data collected from this exercise was then used to input to air dispersion modelling using ADMS 3 by Cambridge Environmental Research Consultants (CERC). Emission factors were obtained by CERC from the emissions factor database operated by RSK Environment on behalf of the DETR. The maximum 90.14th percentile of 24 hour mean concentrations (representing no more than 35 exceedances per year) and the maximum annual mean concentrations are shown below.

Table 24. **Modelled PM concentrations at Del Monte, West Lynn (ug/m^3)**

	90.14th percentile of 24 hour mean			**Annual mean**		
	Predicted	**Standard**	**% of standard**	**Predicted**	**Standard**	**% of standard**
Process contribution	1.8	50	4	0.6	40	2
Process contribution + background	25.8	50	52	24.6	40	62
Location	561500,320200			561400,320200		

Even after the rounded up background concentration of 24µg/m^3, gravimetric is taken into account, the predicted concentrations of PM_{10} are well below the objective values.

There are no busy roads in the vicinity of the maximum predicted impacts. As regard relevant locations there are domestic properties west of the facility with gardens at a minimum distance of about 30 m from the stack.

Given the above it is considered unlikely that there is a significant risk of exceeding the objective from this source. [For report see Technical Annex].

There have been some complaints to the department in the past regarding such operations although subjective evidence does not suggest regular problems.

4 Quarries and Landfill Sites

Liaison was established with Norfolk County Council Planning and Transportation Department in order to gather information on current and planned workings.

Details of mineral extraction and waste disposal operations was also gained from the Norfolk Minerals Local Plan (1996)[29] and Norfolk Waste Local Plan (1997)[30] respectively which is produced and published by Norfolk County Council. Both plans run until 2006 and are subject to review.

Given the above information and local knowledge each site was assessed for the significance of dust emissions both presently and given the likelihood of future developments, bearing in mind the proximity of residential properties where public exposure is likely. Particular attention was paid to the sources of emissions (as opposed to the site boundaries) given that TG4(00) (DETR 2000) states that with an estimated annual mean PM_{10} concentration of <25µg/m^3, gravimetric in 2004 there is no need to carry out further assessment unless properties lie within 200 m of the source. Clearly there is a difficulty in predicting PM_{10} emissions during future workings and it is therefore appropriate to review any changes as part of the Council's Air Quality Strategy and at the time of the next review and assessment in 2003.

The following **mineral extraction** sites were identified within the Borough as being active or potentially active:-

1) Frimstone, Crimplesham - sand/gravel.
2) RMC Aggregates, Tottenhill - sand/gravel - not presently worked although plans have been submitted (October 2000) for further workings.
3) King's Lynn Sand & Gravel, Middleton/Blackborough End - sand/gravel.
4) Sid George, Blackborough End - sand/gravel.
5) Middleton Aggregates, Middleton/Blackborough End - sand/gravel/carrstone.
6) Frimstone Limited, Blackborough End - carrstone/sand.
7) Frimstone Limited, Snettisham - carrstone etc.
8) Frimstone Limited, Feltwell - sand/gravel etc.
9) Sibelco Minerals & Chemicals Limited, Leziate - sand.
10) A M White, Stoke Ferry - sand/gravel.
11) West Norfolk Superlime Co Limited, Hillington - chalk.
12) Longwater Sand & Gravel Co Limited, Coxford - sand/gravel.

The following waste disposal sites were identified within the Borough:-

1) Anti Waste Limited, Feltwell.
2) NEWS Limited, Docking.
3) Anti Waste Limited, Middleton/East Winch.
4) King's Lynn Sand & Gravel, Middleton/Blackborough End.
5) A White, Stoke Ferry.
6) Frimstone Limited, Snettisham.

Many of the landfill/waste disposal sites are within or adjacent to mineral extraction areas.

In general, areas are away from centres of population.

Assessment for mineral extraction areas.

Appendix 9 indicates observations made subjectively regarding the significance of dust and hence fine particle emissions from sites.

There were no sites where it was apparent that there was obvious significant emissions warranting further examination. There are locations where expansion/relocation of operations is likely to occur closer to residential properties before 2005. It is proposed that individual situations are reviewed as part of the Council's Air Quality Strategy.

Assessment for waste disposal areas

Appendix 9 indicates observations made subjectively regarding the significance of dust and hence fine particle emissions from sites. There were no sites where it was apparent that there was obvious significant emissions warranting further examination.

Haul roads - as well as assessing workings and disposal operations note was made of haul road locations in relation to residential development, condition and cleanliness. It was not considered that haul roads appeared to be significant potential sources of dust and hence fine particles at present at the sites examined. No complaints have been presented by the department as regards dust nuisance from any of the sites in question.

14.2.2.3 **Road transport**

As identified in Section 14.1.5.3 there are a number of roads in the Borough which require further consideration.

In accordance with TG4(00) (DETR, 2000[3]), the revised Design Manual for Roads and Bridges (DMRB)[23] methodology was utilised to assess relevant locations where regular public exposure could occur. These were primarily locations where residential occupation occurs next to busy roads. Representative properties were chosen for assessment at each location which were considered to be the most significant for public exposure.

The assessment was carried out for residential gardens in relation to the 24 hour standard and the facades of residential properties for the annual mean reflecting the potential for regular public exposure. Distances were measured from scaled Geographical Information System (GIS) maps or physical measurements.

The assessment has been carried out for 2004 although comparison is made with a roadside location where continuous automatic PM_{10} monitoring was carried out for 16 months between April 1999 and August 2000. This location is Southgates Park, London Road, King's Lynn besides the town centre arterial road. The comparison between DMRB outputs for 1999 and verified data from continuous monitoring for the same period helps establish the validity of the model. The data is subject to a QA/QC and ratification under contract to AEA Technology - NETCEN and therefore can be reported with confidence. (Enclosed as Appendix 7).

Monitoring of PM_{10} – Southgates Park, London Road, King's Lynn

In the period April 1999 to March 2000 the annual mean PM_{10} concentration was 16 $\mu g/m^3$, TEOM which is equivalent to 20.8 $\mu g/m^3$, gravimetric (compared to the standard of 40 $\mu g/m^3$, gravimetric to be achieved by 2005). Over the same period there was 1 exceedance of the 24 hour mean standard of 50 $\mu g/m^3$, gravimetric. This occurred on 11 September 1999 and a concentration of 57.2 $\mu g/m^3$, gravimetric was recorded. The objective for 2005 allows 35 such exceedances per year. The results of this monitoring are shown in Table 19.

Utilisation of the DMRB methodology at this location using estimated data gives a modelled output of between 27.25 and 29.32 µg/m^3, gravimetric depending on traffic speed (see below - Table 25).

Table 25 DMRB modelled PM_{10} concentrations for London Road, Southgates Park, King's Lynn - 1999 annual mean µg/m^3, gravimetric.

Inputs	Speed (km/hour)	Road contribution µg/m^3	1999 Estimated background µg/m^3	Total µg/m^3
1115 vehicles per hour 4% HDV 1999	10	3.46	24	27.46
	15	5.32	24	29.32
	20	4.62	24	28.62
	25	4.17	24	28.17
	30	3.86	24	27.86
	35	3.63	24	27.63
	40	3.46	24	27.46
	45	3.32	24	27.32
	48	3.25	24	27.25

It is estimated that the daily average traffic speed is at least 30 kph, the limit is 48 kph. The above results indicate that the annual mean measured concentration of 20.8 µg/m^3, gravimetric is significantly below that modelled. This indicates that the DMRB methodology is conservative. This should be borne in mind when considering DMRB modelling outputs for other roads in the locality. TG4(00) (DETR 2000)[3] states that where the total annual mean concentration at any road influenced location is predicted to be greater than 28 µg/m^3 there is a risk of the objective being exceeded.

Table 26 DMRB modelled estimates of annual mean PM10 concentrations at relevant locations in the Borough of King's Lynn and West Norfolk, 2004

Location	Estimated annual mean PM10 concentration at relevant location,2004-ug/m3.[Assessment criteria-28ug/m3]
1.London Road,KL-locn.1a	**25.89** (25kph)
-locn.1b	**25.89** (25kph)
-locn. 1c	**25.71**(30kph)
-locn.1d	**25.9** (25kph)
2.Southgates roundabout, KL	**26.68** (20kph)
3.Hardwick Road,KL-locn.3a	**26.28** (40kph)
-locn.3b	**25.18** (40kph)
4.Lynn Road,Gaywood-locn.4a	**25.09** (30kph)
-locn.4b	**26.05** (25kph)
5.Wootton Road, Gaywood	**24.17** (25kph)
6.Railway Road, KL	**27.91** (25kph)
7.Austin St/ Blackfriars St, KL-locn.7a -locn.7b	**25.7** (25kph) **25.1** (20kph)
8.Grimston Rd/ Wootton Rd, S.Wootton	**25.13** (30kph)
9.Saddlebow Rd, KL-locn.9	**25.69** (30kph)
-locn.9a	**24.85** (25 & 20kph)
10.A149,South of hospital, KL	**24.22** (80kph)
11.A47,west of Ouse Bridge, KL	**24.54** (80kph)
12.A47, Middleton	**24.41** (64kph)
13.A149,Cat's Bottom, Sandringham	**23.32** (96kph)
14.A10,West Winch	**24.76** (65kph)
15.A134,Wereham	**24.31** (65kph)
16.A1122/A134 Stradsett	**25.07** (25 & 56kph)
17.A17 Walpole Cross Keys	**24.26** (96kph)

DMRB Modelling of roads

Accordingly the following locations were modelled:

1 London Road, King's Lynn
2 Southgates roundabout junction of Hardwick Road, Wisbech Road and Tennyson Avenue, King's Lynn
3 Hardwick Road, King's Lynn
4 Lynn Road, Gaywood
5 Wootton Road
6 Railway Road, King's Lynn
7 Austin Street/Blackfriars Street, King's Lynn
8 Grimston Road/Wootton Road, King's Lynn
9 Saddlebow Road, King's Lynn
10 A149 south of Hospital, King's Lynn
11 A47 West of Ouse Bridge, King's Lynn
12 A47, Middleton
13 A149, Cat's Bottom or Sandringham
14 A10, West Winch
15 A134, Wereham
16 A134 junction with A1122, Stradsett
17 Walpole Cross Keys - A17
18 A47 Elm High Road, Wisbech

Results: The modelled outcomes are presented in Table 26. Full workings and modelling inputs are presented in Appendix 10. Representative speeds which are considered to be the average over a 24 hour period were subjectively chosen. These speeds were generally below the statutory limit in urban areas, and are viewed as conservative.

As regards Railway Road, King's Lynn, it was noted that the NO_2 diffusions tube reading for this road at a relevant location was 57 µg/m^3. This is estimated to be an over reading by as much as 25% of the actual concentration. (See section 13.2.6) However, DMRB modelling was undertaken which generated an estimated 57 µg/m^3 in 2000 which equated at 25 kph to 1650 vehicles/hour, 5% HDV; 1310 vehicles/hour, 7% HDV. These are traffic flows which are almost certainly in excess of the actual flows. Nevertheless these flows have been given growth factors of 13% from 1997 to 2004 to provide estimates of PM_{10} concentrations using DMRB for 2004. This conservative approach only gives a slight exceedance of the screening objective (28 µg/m^3) at a speed of 15kph which is considered unrealistically low. The estimated daily average speed is considered to be at least 25kph and at this speed the PM_{10} background + traffic component would be 27.46 µg/m^3. The traffic flows and HDV component to generate these PM_{10} concentrations are significantly above that projected by NCC. For example, in 2004 NCC estimate that the traffic flow in Railway Road will be 19096 AADT, 4% HDV. The above estimates are based on traffic flows of 42360 AADT, 5% HDV and 25776 AADT, 10% HDV. These vehicle flows are unlikely (See Appendix 10).

Conclusion - none of the roads modelled are expected to exceed the assessment threshold of 28 µg/m^3 in 2004. Thus it is not considered that there is a significant risk of the objectives being exceeded from road borne PM10 emissions in the Borough.

14.2.2.4 **Combined sources**

There are several public exposure locations where industrial/commercial sources of PM10 could combine with road traffic emissions. Generally such locations are only expected to be adjacent to busy roads as predicted background concentrations produced by the DETR on the worldwide web take into account estimates of combined emissions in each 1km by 1km grid square.

These locations are :-

London Road, King's Lynn which may be subject to PM10 emissions from the coal fired boiler plant located at Del Monte, West Lynn and to a much lesser extent RMC Roadstone. Modelling undertaken to assess these sources indicates at London Road the contribution to the annual PM10 concentration could be approximately 0.05 µg/m^3 and 0.2 µg/m^3 to the 90.14th percentile of 24 hour mean. (See Technical annex for modelling). Monitoring however has shown annual mean concentrations in the area of 20.8 µg/m^3, gravimetric.

Railway Road, King's Lynn - the industrial emissions are estimated from modelling to contribute 0.3 µg/m^3 to the annual mean which is considered to be conservative (see 14.2.2.1 and 14.2.2.2) using the methodology in TG4 (00)[3], the combined impacts are below 50 µg/m^3, gravimetric.

North Lynn - at this location there are combined impacts from port activities, the roadstone coating plant, Del Monte and Edward Benefer Way which is a road predicted to carry about 17482 (3% HDV) AADT by 2004. The emissions from roadstone coating, and the road have been assessed and are reported in Section 14.2.2. Monitoring in the locality since August 2000 indicated no exceedances of the standard objectives in the period up until 31 December 2000. Although the data for October - December is subject to ratification by AEA - NETCEN, there is reasonable confidence that there have been no exceedances over this period. Being on the edge of an urban area it is expected that during the winter months there will be some contribution from solid fuel burning in the locality although it is not considered that there is a significant risk of the objectives being exceeded in this locality or the others mentioned.

14.2.2.5 **Domestic Sources**

There is no existing black smoke data available in the Borough to utilise in the review and assessment. The first stage methodology laid down in TE4(00) ($DETR^{2000}$) has been utilised as part of the 2nd stage review and assessment due to the paucity of information when the 1st stage was undertaken in 1999. As stated in 15.2 (Sulphur Dioxide Second Stage Review and Assessment) the assumption has been made that 20% of properties outside the main settlements which have access to piped gas supplies burns solid fuel. As indicated in Section 14.1.6 the range in estimated annual average background PM^{10} concentrations in 2004 is 22.5 µg/m^3 to 23.4 gravimetric across the Borough. In rural areas concentrations below 22.7 µg/m^3 are the norm. Utilising the above methodology in a small village at least 1600 persons would have to live in solid fuel burning households per km^2 to require further consideration given an annual average background concentration of 22.7 µg/m^3 in 2004. Utilising census data (NCC - 1991) the Borough has an average of 2.4 persons per household. Assuming 20% solid fuel use and 40% open space per km^2 in a typical village (Great Massingham) would mean that about 600 persons living in coal burning households. This is set against a threshold of 1600. Even if solid fuel (including wood) burning was 50% then the threshold would not be exceeded.

In a small town 900 persons would have to live in solid fuel burning households to exceed the threshold for further consideration (at the same estimated background concentration). Small towns (16km^2 area) in the Borough are all served by piped gas suppliers. Given the above it is not considered likely that the densities of solid fuel burning will be reached to warrant further consideration in review and assessment.

14.3 SECOND STAGE ASSESSMENT FOR FINE PARTICLES (PM_{10})

The 1st stage review and assessment, given the information available at the time, indicated that the risk of exceeding the objectives in relevant locations was not negligible.

Further work including monitoring and modelling has indicated that there is not a significant risk of the objectives being exceeded from road sources and industrial emitters identified in the first stage review and assessment.

There is insufficient evidence to have reasonable confidence that there is not a significant risk of the objectives being exceeded at relevant locations in the locality of King's Lynn Port and in particular the South Quay from fugitive emissions.

It is therefore recommended that the Authority undertakes a Third stage review and assessment of the above sources. This work is to be completed the end of June 2001 by AEA NETCEN.
Monitoring will continue and an Air Quality Strategy drawn up to review identified issues.

14.4 THIRD STAGE REVIEW AND ASSESSMENT FOR FINE PARTICLES

14.4.1 Position statement

AEA NETCEN were contracted by the Borough to undertake a Third stage review and assessment of the above mentioned sources. The outcome of this work is the subject of a separate report.

It should be acknowledged that by their nature port activities are variable and therefore estimating future emissions with confidence can pose difficulties and therefore a review of activities will form part of the Borough's Air Quality Strategy and the next review and assessment in 2003.