Draft Report on Turnkey Osiris Particle Results at the Market and Havre des Pas Sites in Jersey for 2007

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2. Particles: Sources and Health Effects

Particles in the atmosphere originate from a wide variety of sources. They take the form of dust; smoke of very small liquid or solid particles called aerosols. Particles may be either emitted directly into the atmosphere (ie primary particles) or formed subsequently by chemical reactions (ie secondary particles). PM_{10}, (particles are defined as having an average particle size of 10 microns in diameter (10 millionths of a metre), and have well documented respiratory effects on human health. These include effects on the respiratory and cardiovascular systems, asthma and mortality. PM_{10} particles are composed of primary combustion derived carbon-centred particles e.g. ultrafines, secondary particles from atmospheric chemistry eg ammonium nitrate, natural minerals e.g. soil, wind-blown, biological e.g. spores, bacteria and metals. (See Appendix 4)

Studies have shown that most of the inflammation in the lungs could be explained by the mass of particle instilled, however, mass could not account for all of the variability in the data. It is believed the presence of metals such as iron, zinc, lead and nickel content of PM_{10} had the best association with inflammation out of all of the compositional measurements analysed. Primary particulate content of PM_{10} was also positively associated with inflammation.[2]

The Expert Panel on Air Quality Standards (EPAQS) concluded that particle air pollution episodes are responsible for causing excess deaths among those with pre-existing lung and heart disease. EPAQS also believe that any risk of lung cancer from the concentrations found in the streets of the UK is likely to be exceedingly small. However prolonged exposure for example 20 - 30 years to particles, which are likely to be combined with Polycyclic Aromatic Hydrocarbons (PAH) originating from unburnt or partially burnt fuel, is likely to be carcinogenic.

There is a wide range of human activities that produce particle emissions, including; motor vehicles (mainly diesel), solid fuel burning, industrial processes, power stations, incinerators and construction activity. The main sources of anthropogenic (ie man made) particles in Jersey are from transport, the incinerator and domestic fuel burning. The oil fired power station in Jersey only runs for a few months a year and approx 97% of Jersey's energy comes from France via 2 under sea links.

Emissions from mainland Europe may make a significant contribution to secondary particles in Jersey. The UK Airborne Particles Expert Group's findings suggest that in a typical year with typical meteorology, about 15% of the UK's total annual average PM_{10} concentrations (about 50% of secondary particles) are derived from mainland Europe. In years of higher frequency of easterly winds, with large movements of air from mainland Europe, emissions in mainland Europe account for a considerably higher proportion of PM_{10} concentrations, particularly in south and east England. No work has been carried out to try and establish the contribution of secondary particles originating from Europe onto Jersey.[8]

A UK government Air Quality Strategy Objective and a European Community Directive regulates concentrations of PM_{IO} in the UK (see section 5). The States of Jersey has agreed to work towards the limits set out in the European Daughter Directive 99/30/EC which deals with particles, sulphur dioxide, nitrogen dioxide, and lead. The main issues around air quality in Jersey relate to local air quality and the health impacts associated with high levels monitored mainly at road junctions and along canyon streets[1].

The BBC reports that the amount of solar energy reaching the Earth's surface has declined significantly between the 1950s and the 1990s, apparently due to particulate

air pollution. Scientists are worried that this global dimming may be disrupting the pattern of the world's rainfall. Most alarmingly, it may have led us to greatly underestimate the greenhouse effect: with particulate pollution being brought under control, a global temperature rise of 10 degrees Celsius by 2100 could be on the cards, rendering many parts of the world uninhabitable. It is interesting to see the link between local air quality and global effects.[13]

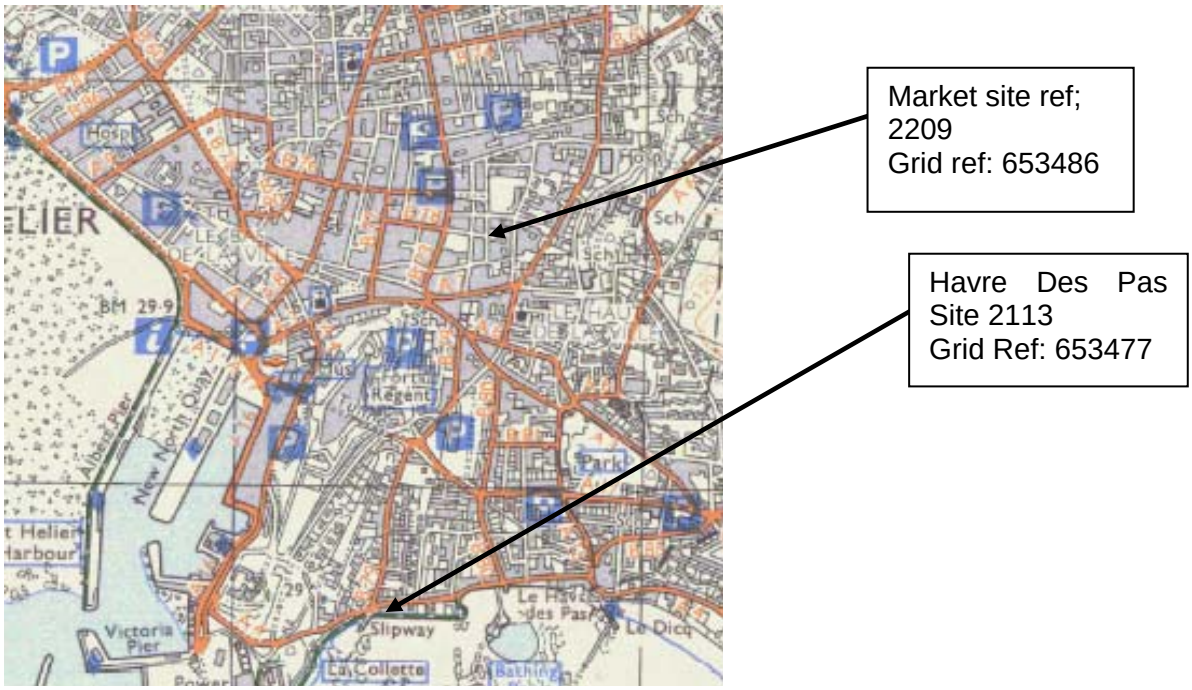
http://news.bbc.co.uk/2/hi/science/nature/4171591.stm

1. The Air Quality Strategy for England, Scotland,, Wales and Northern Ireland. Working Together for Clean Air. January 2000. Cm 4548, SE 20003/3 and NIA 7. The Stationery Office Ltd.
2. Adverse Health Effects of Particulate Air Pollution V. Stone, J.H. Lightbody, L. Hibbs, C.L.Tran, M. Heal, and K. Donaldson. Napier University, University of Edinburgh
8. Report: Particles a problem or not in St Helier 2001- A M Irving
13. Horizon BBC 2 15/01/05

3. Background

Two Turnkey Osiris Particle Monitors (OSIRIS: Optical Scattering Instantaneous Respirable Dust Indication System) (see photograph 1 below) were purchased in 1999 and 2002. They are designed to continuously monitor particle levels, in particular Total Suspended Particles (TSPs), PM_{10} (Particles with an aerodynamic diameter of 10 microns) $PM_{2.5}$ and $PM_{1.0}$. The Osiris units sample particles and provide a 15 minute average level. This report presents the results of the 6th consecutive year of monitoring, calendar year 2007 – covered by the monitoring period January 2007 to December 2007.

Figure 1: The sampling sites in St Helier town centre[9]



Photograph 1: The Turnkey Osiris Unit

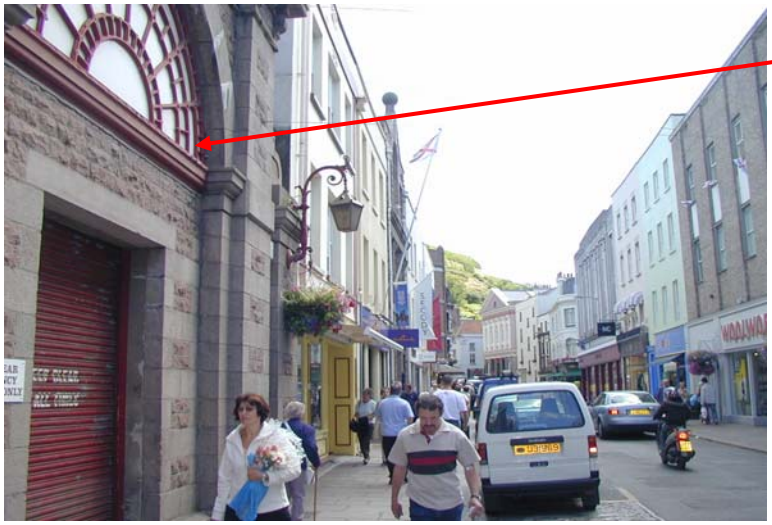
9. Jersey's Official OS Leisure Map 1:25 000 States of Jersey Planning and Environment Department

Each Osiris unit is served by a GSM modem which allows Officers from this Department to dial them up at any time and download the previous 24 hours results using Turnkey's Air Q 32 Software. The data from the sites is emailed daily to the Jersey Meteorological Department and for use on their website ie www.jerseymet.gov.je. This enables public access to the data.

The Osiris units are also fitted with a filter, which traps particles which allows for them to be analysed, sized and counted. The filter analysis allows the weight of particles to be determined and compared with the Osiris' computer calculated weight (ie to assess the accuracy of the Osiris). The analysis of the filter is by a UK company TES Bretby. This analysis also allows an indication of the sources of the particles and a percentage source contribution. The results are provided in section 4 and Appendix 6.

The Osiris unit at the central market is sited approximately 4m above the pavement and approximately 3m from Halkett Place. This road is used by up to 10,000 vehicles per day with up to 1000 per hour at rush hour periods. The peak hours are around 8.00 am and between 3.00 pm and 5 .00pm each day (see the photograph 2 below). Previous work has shown that particle levels follow traffic numbers, mix and speed closely. The site is also a busy pedestrian area.

Photograph 2: The Position of the Osiris Unit at the central market Halkett Place St Helier



The second unit was moved to the Havre Des Pas site in September 2006 and sited on the De La Plage apartments. It was sited there to measure particle levels associated with traffic driving to La Collette via Havre Des Pas. It is designed to measure an indicative background level for screening purposes. This information was designed to assist Traffic and Transport Services (TTS) by providing screening data for the Health Impact Assessment associated with the proposed Energy from Waste plant (EFW) proposed for La Collette.

Photograph 3: Position of the Osiris unit at Havre Des Pas

4. Results

The particle exceedances (ie PM_{10}) and air pollution results are presented below.

The results are as follows:

1. The Market site from 13th April to 31st December 2007 inclusive showed the EC and UK Air Quality objectives were not exceeded at any point during this period[1]. Prior to April 2007 the Osiris unit 2209 was being used for a post smoking ban survey at three licensed premises and was sent to Turnkey in the UK for servicing and calibration.

2. The Havre Des Pas site results for the period 1st January to 27th June 2007 and 2nd October to 31st December 2007 showed the EC and UK Air Quality objectives were exceeded 44 times. The period between the end of June and October the Osiris unit 2113 was in the UK being serviced and calibrated.

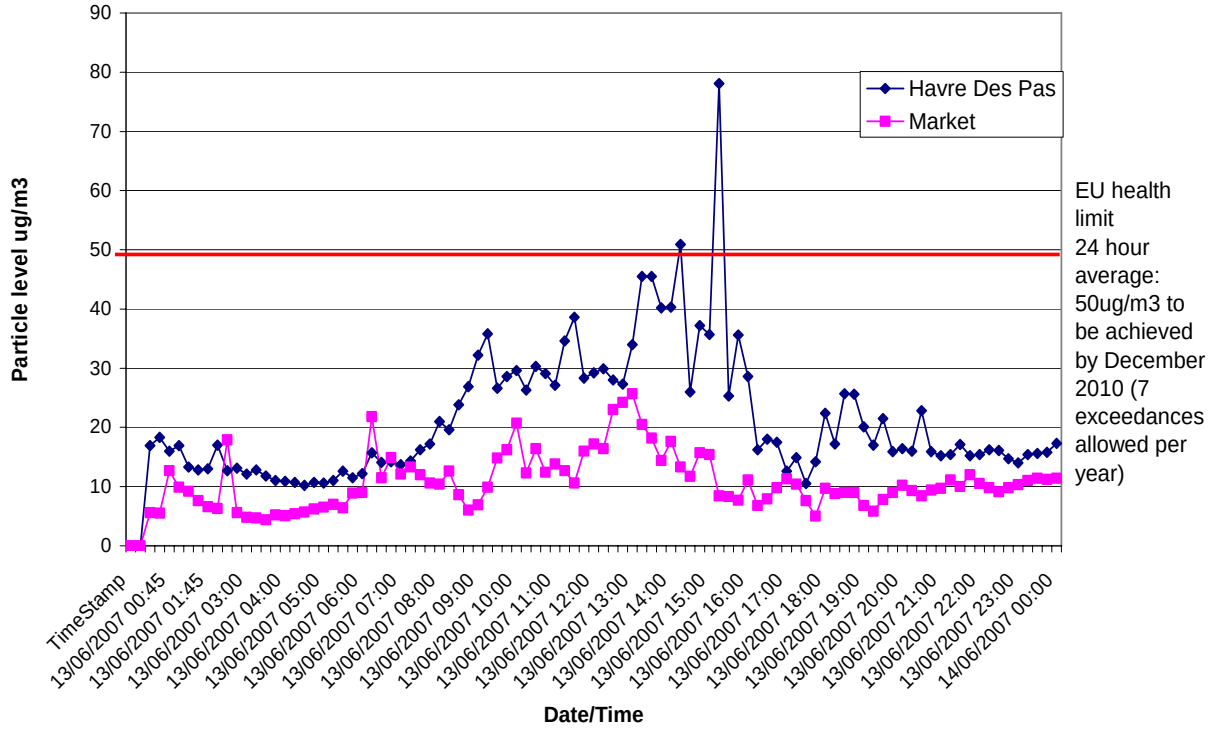
The EU objectives (ie Stage 2) only allow 7 exceedances per calendar year and should be complied with by 2010 in the UK. In a recent UK Government consultation on the National Air Quality Strategy, it was noted that the European Commission is developing a new Air Quality Directive and that the Commission has recognised that continuing to pursue the indicative 2010 limit values for particles is unlikely to generate a cost effective improvement in air quality. Therefore, it seems unlikely that the 2010 objectives will ever be included in UK legislation.

Figure 3 below shows an example of particle levels over a 24 hour period on Wednesday 13th June 2007 at both sites. Levels of particles increase up to 09.00 am, lunch time and peaking at approximately 16.00 at Havre Des Pas. At the market site levels increased up to 06.00 due to early morning deliveries and the refuse collection. Levels also increased up to lunchtime at the market site.

Particle levels at the market site have reduced generally since the road layout changed in this area. Traffic can now turn right up Halkett Place thereby avoiding the area by the monitor plus two pedestrian crossings on Beresford Street has meant that traffic congestion is now worse on Beresford Street and has improved along Halkett Place. Particle levels follow traffic volume, mix and are influenced by traffic speed ie congestion and meteorological conditions

Figure 3: Particle measurements at the Havre Des Pas and Market sites on Wednesday 13th June 2007

PM_{10} particle levels at the Havre Des Pas and the Market sites on Wednesday 13th June 2007



The Turnkey Osiris Particle Monitor uses a heated inlet (50ºC) to evaporate water vapour particles which would otherwise result in inaccurately high readings. However it is now accepted that evaporation of volatiles/particles also occurs; resulting in lower than expected results. Research has suggested that such results should be increased by up to 30% to increase their accuracy. However there are uncertainties as to whether 30% is appropriate in all cases and all geographical areas. Details of the Osiris are provided in Appendix 2.

The relationship between meteorological conditions and particle levels is not clear. As wind speed increase particle levels reduce. The monitor at the Market site is in a street canyon which reduces the dispersion/dilution of particles. As wind passes over the top of the buildings an eddy effect occurs which causes circular dispersion.

At the market site levels of particles spike early morning and this can explained by the presence of delivery/refuse vehicles close to the measurement site resulting in high levels of air pollution.

The monitor at the Havre Des Pas site is also in a street canyon but the site is within 20m of the sea and the prevailing wind direction (SW) means the wind will pass along Havre Des Pas aiding dispersion and dilution. However due to the presence of a number of hotels along Havre Des Pas traffic congestion often occurs due to parked vehicles etc. Traffic congestion will increase particle levels. The proximity of the sea to this site means that sea salt and sand are likely to be a significant source of particles aswell.

The European Union reference method for measurement uses of a gravimetric (filter based) system to measure compliance; the UK has suggested that its preferred Tapered Element Oscillating Microbalance (TEOM) measuring devices are adequate if the results are multiplied by up to 1.3 (30%). Although the Osiris is not as accurate as

the TEOM it provides useful indicative results.

1. Air Pollution Bandings:	As a running 24 Hour mean	Market (days)	Havre Des Pas
Low Air Pollution:	<50 µg/m^3	262	233
Moderate Air Pollution:	50 - 74 µg/m^3	0	39
High Air Pollution:	75 - 99 µg/m^3	0	5
Very High Air Pollution:	>= 100 µg/m^3	0	0

According to the above bandings air pollution levels were very low at the market site but there was 39 days of moderate pollution and 5 days of high air pollution at the Havre Des Pas site.

	Market	Havre Des Pas
2. 24 Hour daily mean: 50 µg/m3 not to be exceeded more than 35 times per calendar year by 2004 and 7 times per calendar year by 2010.	0	44
3. Calendar Year Annual Mean: 40 µg/m3 (Stage 2: 20 µg/m3)	18.8 (262 days)	32.8 (147 days)

The tables above show that PM_{10} particle results exceeded the 24 Hour daily mean of 50µg/m3 44 times at Havre Des Pas. This exceeded both the 35 allowable exceedances to be achieved by the end of 2005 and 7 exceedances to be achieved by end of December 2010[12]. There were no exceedances at the Market site. Stage 2 limits allow only 7 exceedances of 24 Hour daily mean 50µg/m3 per year however this limit is under review

Although both the sites comply with the Stage 1 annual mean value of 40µg/m3 the market and Havre Des Pas sites fail the Stage 2 annual mean objective of 20µg/m3 **(Note: The annual mean results provide a guide as a full calendar year of results were not obtained**).

The glass fibre filter in the Havre Des Pas unit was analysed in July 2007. The market unit filter was analysed in April 2008

The results from the Havre Des Pas filter analysed by TES Bretby Ltd are summarised below. The examination procedure (ie Scanning Electron Microscopy and Energy Dispersive X Ray analysis) is based on the assessment of approximately 40 individual particles selected at random. The estimated percentage is based on a comparison of the relative number of particles counted in each category. (See Appendix 5 for the test reports and scanning electron micrographs).

12. EU Daughter Directive 99/30/EC.

Note: Care must be taken interpreting theses results as only a very small number of particles were analysed. Unfortunately the costs are prohibitive for greater in depth analysis.

The results are as follows:

a. Havre Des Pas Site : Examination revealed that the collected deposit was mainly carbonaceous matter (23%) associated with vehicular emissions. Other materials present included: Sodium/Chlorine rich (18%) which indicates sea salt, Aluminium/Silicon rich (18%), Plant animal fragments (15%), Potassium/Aluminium/Silicon rich(15%), Iron rich (2%) are classified as general dirt

b. Market site: Examination revealed that the collected deposit was mainly carbonaceous matter (55%) associated with vehicular emissions. Other materials present included: Sodium/Chlorine rich (20%) which indicates sea salt, Aluminium/Silicon rich (7%) which indicates sand, Plant animal fragments (10%), and Potassium/Aluminium/Silicon rich (8%).

Interestingly the percentage of particles from vehicular emissions is higher at the market site than Havre Des Pas site. This is to be expected as traffic volume is greater at Halkett Place. The levels of Sodium/Chlorine particles are similar at both sites suggesting sea salt travels inland in aerosol form as at the coast. The percentage of sand particles is higher at Havre Des Pas due to its proximity to the beach and they are heavier and fall out quicker.

Levels of particles increased at Havre Des Pas in high winds and this is likely to be due to sand and salt particles. It was also felt that the Jersey Electricity Company oil fired power station chimney which is approx 300 m away may be affecting the results. Analysis of a filter in April 2008 by AEA Technology [14] suggested there was little or no interference from the power station however the most significant sources were sea salt and sand

There were two interesting observations made by AEA technology:

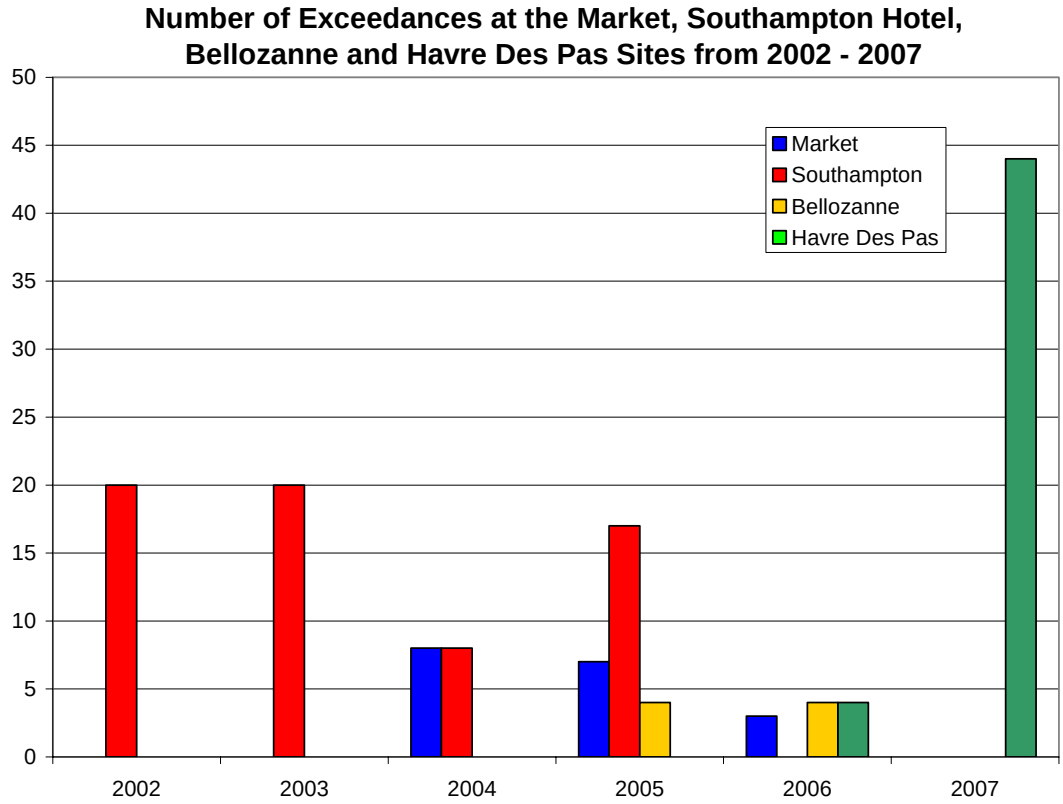
1. The presence of Lanthanum particles in trace quantities. It is found in catalytic converters assisting converting NO_2 to Nitrogen and in flints for cigarette lighters. It does occur naturally but in very small quantities in the earth's crust.

2. No Vanadium was detected, suggesting that either the power station was not operational, or not an influence for this exposure period.

AEA technology has recommended PTFE filters are used to assist analysis as glass fibre filter material can interfere with the analysis.

14. AEA Technology report Ref Brian Stacey Analysis of Particulate matter (dust) on filter using SEM and EDX April 2008

Figure 4: Comparisons with the 2002 to 2007 data



The graph above shows that the number of exceedances for the Southampton hotel, Bellozanne and Havre Des Pas sites for 2002 - 2007. These are lower than in previous years. There was a large number of exceedances for the Havre Des Pas site in 2007 (44) which may be due in part to salt and sand particles. Care needs to be taken in direct comparison as the measurement periods varied.

5. EU and UK Guidelines

In Jersey the States have agreed to work towards the European Union Directive objectives[6]. However in the UK, air quality standards and objectives for the major pollutants are described in the Air Quality Strategy for England, Scotland, Wales and Northern Ireland 2000 (The National Air Quality Strategy, or NAQS)[1]. An Addendum to NAQS was published in 2003, leading to some tighter air quality objectives.

The NAQS includes air quality objectives defined under European Directives, specifically the Air Quality Framework Directive (96/62/EC) and the four so-called Daughter Directives (1999/30/EC, 2000/69/EC, 2002/3/EC and 2004/107/EC), as well as objectives derived from work by the Expert Panel on Air Quality Standards (EPAQS).The NAQS makes a clear distinction between “standards” and “objectives”.

- *Standards* are the concentrations of pollutants in the atmosphere which can broadly be taken to achieve a certain level of environmental quality. The standards are based on assessment of the effects of each pollutant on human health including the effects on sensitive subgroups; and

- *Objectives* are policy targets generally expressed as a maximum ambient concentration to be achieved, either without exception or with a permitted number of exceedences, within a specified timescale.

Under the EC Air Quality Framework Directive (96/62/EC), all Member States have to assess their existing air quality and implement a programme of monitoring, dependent upon population, population density, emission sources and proximity of the general public to these sources.

Under the Framework Directive, a Member State MUST undertake continuous monitoring (using appropriate instrumentation) at least ONE site.

NETCEN recommend, therefore, that the island undertakes continuous monitoring for NO_2 and PM_{10}. For the first year at least, this was at the highest known pollution "hotspot" (Weighbridge). Once compliance with the Daughter Directive(s) is confirmed at this location, the site could be relocated to an area more representative of general population exposure (eg residential or urban background)[6]

The EU Directive also details an: (24 hour limit value)

(a) **Upper Assessment threshold**: 60% of the limit value (30µg/m^3) not to be exceeded more than 7 times in any calendar year.

(b) **Lower Assessment threshold**: 40% of the limit value (20µg/m^3) not to be exceeded more than 7 times in any calendar year.

The upper and lower Assessment thresholds are presently being exceeded. Improvement in traffic management flow reduction will be needed to ensure the Upper Assessment threshold (UAT) is not exceeded in 2010[11].

Air quality should improve as the benefits of improved engine design Euro 4/5 are seen. The relocation of the bus station to the Island site, further road changes as part of the St Helier Life program and general town centre improvements will also help. The reviewed Air Quality Strategy and the TTS Sustainable Traffic and Transport Plan will raise the profile of Air Pollution and the measures needed to reduce it.[5]

In the recent UK Government consultation on the air quality strategy, it was noted that the European Commission is developing a new Air Quality Directive and that the Commission has recognised that continuing to pursue the indicative 2010 limit values for particles is unlikely to generate a cost effective improvement in air quality. Therefore, it seems unlikely that the 2010 objectives will ever be enacted in legislation.

The EU and UK guidelines include:

1. Air Pollution Bandings:	As a running 24 Hour mean
Low Air Pollution:	<50 µg/m^3
Moderate Air Pollution:	50 - 74 µg/m^3
High Air Pollution:	75 - 99 µg/m^3
Very High Air Pollution:	>= 100 µg/m^3

2. 24 Hour daily mean: 50 µg/m3 not to be exceeded more than 35 times per calendar year by 31.12.2004 and 7 times per calendar year by 31.12. 2010. (NB Stage 2 Limits are under review)

3. Calendar Year Annual Mean: 40 µg/m3 (Stage 2: 20 µg/m3 to by achieved by 31.12.2010)

1. The Air Quality Strategy for England, Scotland,, Wales and Northern Ireland. Working Together for Clean Air. January 2000. Cm 4548, SE 20003/3 and NIA 7. The Stationery Office Ltd.
5. An Air quality Strategy for Jersey, April 2003. NETCEN
6. Air Quality Monitoring , St Helier, February to March 2000. NETCEN
11. EU Directive 96/62/EC on Ambient Air Quality Assessment and Management (The Air Quality Framework Directive)

6. Improvements in particle levels in Jersey

PM_{10} concentrations in Jersey were generally higher than the UK comparison sites[5] but broadly similar to those found in London and Bristol. Levels at the Havre Des Pas and Market sites are broadly what could be expected at a roadside location in the UK.[5]

Particle levels from other sources such as the power station have reduced with the use of the two cable links to France (ie up to the end of September 2003 97% of electricity used in Jersey originated from France).

The Easy link coach service began on the 19th April 2003. There are 10 to 15 buses operating with poor emissions compared to the cleaner Connex buses which have Euro 3 engines. When these engines are used in conjunction with low-sulphur diesel, emissions are very much lower. An aim should be to fit continuously regenerating particulate traps to Euro 2 and earlier diesel engines. (The cost is up to £3,500 per vehicle but 90% of particles can be removed).

Other options available are to move towards gaseous fuels such as the vehicles operated by Jersey Gas. The availability of bio-diesel in Jersey in the near future should lead to improvements. In London the trialling of water diesel emulsion is occurring which is claimed to halve particle emissions and cut Oxides of Nitrogen (NOx) by 23%.

Other schemes that benefit air quality include:

(A) The installation of two new cremators which comply with the UK Environmental Protection Act 1990 Process Guidance notes

(B) The commissioning of a new Energy from Waste (EFW) plant.

(C) New Building Byelaw Part L to improve insulation in domestic properties improving Reducing fuel consumption by improving the thermal insulation of new build properties.

(D) The provision of a third electricity link to France will reduce the need to run the JEC oil fired power station.

(E) The growth in the use of solar panels, wind generators and heat pumps will reduce the reliance on traditional fossil fuels; thereby reducing particle emissions from domestic premises.

5. An Air quality Strategy for Jersey, April 2003. NETCEN

7. Conclusions

1. The Turnkey Osiris particulate monitors were set up at the Central Market on Halkett Place and Havre Des Pas St Helier. The units measure particles in real time (ie Total Suspended Particles (TSP), particles of a mean aerodynamic diameter of 10 microns (PM_{10}), and particles of a mean aerodynamic diameter of 2.5 microns ($PM_{2.5}$) and particles of a mean aerodynamic diameter of 1 micron ($PM_{1.0}$) as 15 minute averages. Exceedances at Havre Des Pas in 2007 ie 44 may be partially attributed to particles of sand and salt.

2. Particles are associated with a range of health effects. These include effects on the respiratory and cardiovascular systems, asthma and mortality. The Expert Panel on Air Quality Standards (EPAQS) concluded that particle air pollution episodes are responsible for causing excess deaths among those with pre-existing lung and heart disease. EPAQS also believe that any risk of lung cancer from the concentrations found in the streets of the UK is likely to be exceedingly small. However prolonged exposure for example 20 - 30 years to particles, which are likely to be combined with Polycyclic Aromatic Hydrocarbons (PAH) originating from unburnt or partially burnt fuel, is likely to be carcinogenic[2].

3. The Osiris has a glass fibre filter which collects particle material, which was further analysed to determine the sources of the particles and percentage contribution. Examination revealed in 2007 that the collected deposit was varied including sea salt, sand, general dirt and carbonaceous matter with particle size of <10 microns associated with vehicular emissions. Care must be taken interpreting these results as only a very small number of particles (40) were analysed.

4. PM_{10} concentrations in Jersey were generally higher than the UK comparison sites[5] but broadly similar to those found in London and Bristol. Levels at the Havre Des Pas and the Market sites are broadly what could be expected at a roadside location in the UK.

5. Concentrations of all pollutants appear to be falling over time. This is likely to be due to improved fuel composition and engine design[5]. However directive limits are becoming tighter and more health information is readily available.

6. Particle levels from other sources such as the power station have reduced with the use of the two cable links to France (ie up to the end of September 2003 97% of electricity used in Jersey originated from France).

7. The main air quality issues in Jersey relates to the impact of traffic on local air quality.

8. Particles have been implicated in global dimming (ie the amount of solar energy reaching the Earth's surface has declined significantly between the 1950s and the 1990s, apparently due to particulate air pollution) and it may have led us to greatly underestimate the greenhouse effect. With particulate pollution being brought under control, a global temperature rise of 10 degrees Celsius by 2100 may result, rendering many parts of the world uninhabitable. This highlights the relationship between local air quality and global warming.[13]

2. Adverse Health Effects of Particulate Air Pollution V. Stone, J.H. Lightbody, L. Hibbs, C.L.Tran, M. Heal, and K. Donaldson. Napier University, University of Edinburgh

5. An Air quality Strategy for Jersey, April 2003. NETCEN
13. Horizon BBC 2 15/01/05

8. Recommendations

1. Further long term research (until at least 2010) should be carried out to assess levels of PM_{10}/$PM_{2.5}$ in Jersey associated with traffic numbers, its mix, and speed and meteorological conditions to establish trends and assess compliance with the European Union Daughter Directive objectives. This forms part of the integrated Air Quality Strategy. Further monitoring should involve the use of EU type approved measurement equipment to be meaningful and allow direct comparison with the UK.

2. Traffic data (eg volume, mix and speed) should be made available to allow more meaningful comparison with particle results.

3. Further work is needed to assess the relationships between meteorological data and particle levels.

4. Comparison between TEOM monitoring of PM10 and the Osiris units to determine if a factor is needed to account for the loss of volatiles from the heated sampling head.

5. A review of the Department's Air Quality Strategy is necessary.

6. Work is needed in conjunction with other stakeholders to promote measures to reduce particles mentioned in section 6.

9. Appendix 1: The results compared to the UK/EU standards

Results for 2005		Sites		
1. Air Pollution Bandings: (days)	As a running 24 Hour mean	Market (corrected) days	Bellozanne	Havre Des Pas
Low Air Pollution:	<50 µg/m^3	175 (170)	72 (70)	101(84)
Moderate Air Pollution:	50 - 74 µg/m^3	3 (8)	2 (2)	7 (24)
High Air Pollution:	75 - 99 µg/m^3	0	1 (2)	0
Very High Air Pollution:	>= 100 µg/m^3	0	1 (2)	0
2. 24 Hour daily mean: 50 mg/m^3 not to be exceeded more than 35 times per calendar year by 2004 and 7 times per calendar year by 2010.		3 (175 days-8 corrected)	16.78 (21.81) 76 days	31.59 (36.4)104 days
3. Calendar Year Annual Mean: 40 mg/m^3		21.34 (27.74) 178 days	37.49 (48.73) 134 days	24.82 (32.26) 94 days
4. The EU Directive also details an: (24 hour limit value)				
Upper Assessment threshold: 60% of the limit value (30µg/m^3) not to be exceeded more than 7 times in any calendar year.		Yes	Yes	Yes
Lower Assessment threshold: 40% of the limit value (20 µg/m^3) not to be exceeded more than 7 times in any calendar year.		Yes	Yes	Yes

The upper and lower Assessment thresholds are presently being exceeded. Improvement in traffic management flow reduction will be needed to ensure the Upper and lower Assessment thresholds (UAT) are not exceeded in 2010.

10. Appendix 2: The Turnkey Osiris Particle Monitor

Osiris stands for *Optical Scattering Instantaneous Respirable Dust Indication System*.

The Osiris is an investigational instrument that fulfils the dual role of a portable instrument or permanent installation.

The instrument is housed in a sturdy die cast metal box with internal rechargeable battery. The external power source was connected for the long term monitoring. The internal memory was used to record PM_{10}, $PM_{2.5}$, $PM_{1.0}$ and Total Suspended Particles (TSP) as 15 minute averages for the monitoring periods. Each 24 hour period is saved in a folder for downloading to a computer and analysing with the Air Quality Programme for Windows. The Air Quality programme allows the data to be graphed and copied into Microsoft Excel for further analysis.

The instrument measures and records the concentration of airborne particles using a proprietary laser (nephelometer). An internal pump continuously draws an air sample through the nephelometer which analyses the light scattered by individual particles as they pass through a laser beam. These same particles are then collected on the reference filter. The nephelometer's dedicated microprocessor can analyse the individual particles even if there are millions of them per litre. This allows the size fractions to be determined at concentrations up to several milligrams/m^3.

The light scattered by the individual particles is converted into an electrical signal which is proportional to the size of the particle. A unique feature of the Turnkey nephelometer is that only light scattered through very narrow angles 10 degrees or less is measured. At this narrow angle the amount of light scattered is virtually the same for say black diesel or white limestone particles of the same size. That is, it doesn't depend on the material composition of the particle. On the other hand, the easier to measure right angle 90° scatter used by some earlier scattering instruments is highly dependant on material composition with white particles apparently scattering much more light than black ones of the same size.

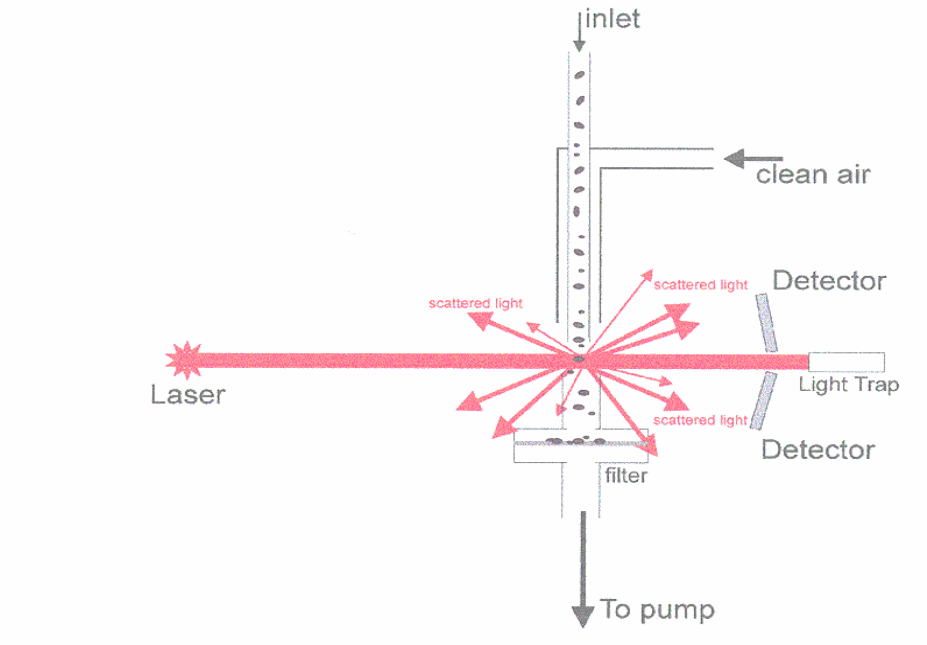
The light scattered by airborne particles can be thought of as consisting of three components. Light reflected from the surface of the particle, light refracted through the particle and light which is diffracted from its original path by the presence of the particle. The intensity of the light scattered by reflection or refraction strongly depends on the type of particle. Thus a white limestone particle will reflect much more light than a black diesel fume particle of the same size. On the other hand the diffracted component depends only on the size of the particle and is independent of its material composition.

For irregularly shaped particles, light, which is reflected and refracted, tends to be scattered over all possible directions. The diffracted component, however, tends to be scattered only through very small angles. For example, for a 5 micron diameter particle, 90% of the diffracted light is scattered by less than 10 degrees from the original direction of the light beam.

The intensity of the light pulse is therefore an indicator of particle size, from this the microprocessor is able to calculate the expected mass of the particle. It assumes the material density of the particle is 1.5 grams per cc, which for most airborne dusts is a good approximation but the mass calibration factor can be adjusted to compensate for different material types.

Having evaluated the mass of the particle, the microprocessor then evaluates the likely chance of deposition of the particle according to the sampling convention being used (PM_{10}, thoracic, and so on) as shown in figure 19 below. Thus for the thoracic convention a 6 micron particle has an 80.5% chance of deposition, hence only this percentage of its evaluated mass is accumulated.

Diagram of the Osiris particle monitor



11. Appendix 3: Relationship between the European transfer reference sampler and other PM10 sampling methods [9]

Monitoring of PM10 in the UK networks has, to date, been largely founded on the use of the TEOM analyser. A concern with the TEOM instrument is that the filter is held at a temperature of 50°C in order to minimise errors associated with the evaporation and condensation of water vapour. This can lead to a loss of the more volatile particles (such as ammonium nitrate etc).

The EU limit values and the UK objectives are based upon measurements carried out using the European transfer reference sampler, or equivalent. This is a gravimetric sampler, where the particulate material is collected onto a filter, and subsequently weighed. The filter is therefore held at fluctuating ambient conditions during the period of exposure. Whilst there will inevitably be some losses of volatile species from the filter (dependant upon the ambient temperature), these will be less than from the TEOM.

The Government and the Devolved Administrations have been investigating the relationship between the TEOM and the reference sampler, using co-located instruments at 6 sites in the UK. These studies have shown that the TEOM adjustment factor is site specific, and varies both from season to season, and from year to year. Because of this **an interim default adjustment factor of 1.3** has been proposed for the UK. This approach is supported by other studies carried out in other EU countries, and appears to also apply to ß-attenuation instruments with a heated manifold.

For the purpose of the next round of review and assessment, authorities should bear in mind the issues set out below:

- Measurements of PM10 concentrations carried out using the European transfer reference sampler, or equivalent, are directly comparable with the UK objectives and EU limit values, and no data correction is necessary. There are, however, important QA considerations to bear in mind, regarding the handling and weighing of filters.

- Measurements of PM10 concentrations carried out using a TEOM or ß-attenuation instrument, operating with a heated manifold, should be adjusted by multiplying the data by 1.3 to estimate gravimetric equivalent concentrations.

- Measurements of PM10 concentrations carried out using other sampling methods (e.g. optical analysers, or gravimetric samplers that have not been certified as ‘equivalent’) will need to be considered carefully, particularly if they are being used in a Detailed Assessment, and the concentrations measured are close to the objectives. Authorities with such analysers are advised to contact the relevant Helpdesk .

- It is not recommended that authorities carry out local intercomparison studies between the transfer reference sampler and other samplers for the purpose of review and assessment. Where such studies are carried out, it is **essential** to carry out the comparison over at least 6 months, including a summer and winter period. Any adjustment factors derived may be both season and site specific, and cannot simply be used to adjust data at other sites, in other years.

- The method of sampling is **critical** to the result. In all cases, authorities should explicitly state the method of sampling, and report all original and ‘adjusted’ data.

12. Appendix 4: Sources of particles

Box 8.1: Approximate contributions to PM_{10} concentrations (2002)

Type of particle	Source location	Main source categories	Main source types	Typical contribution to annual mean concentration ($\mu g/m^3$ gravi.)
Coarse 2.5-10µm	Immediate local (very close)	Traffic	resuspended dusts tyre wear	1 - 6
		Industry	fugitive dusts stockpiles quarries construction	variable, up to 5
	Urban background	Traffic	resuspended dusts tyre wear	1 - 2
		Industry	fugitive dusts stockpiles quarries construction	variable, up to 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 - 4
		Industry	combustion industrial processes	variable
		Domestic	coal combustion	variable
	Urban background	Traffic	vehicle exhaust	1 - 4
		Industry	combustion industrial processes	variable, up to 8
		Domestic	coal combustion	variable, up to 8
	Regional (including distant sources)	Secondary	power stations industrial processes vehicles	4 - 8
		Primary (Imported)	power stations vehiclesw industrial processes	1 - 2
		Natural	sea salt	<1

13. Appendix 5 TES Bretby Ltd test reports and scanning electron micrographs.

a. Central Market Site:

TES Bretby

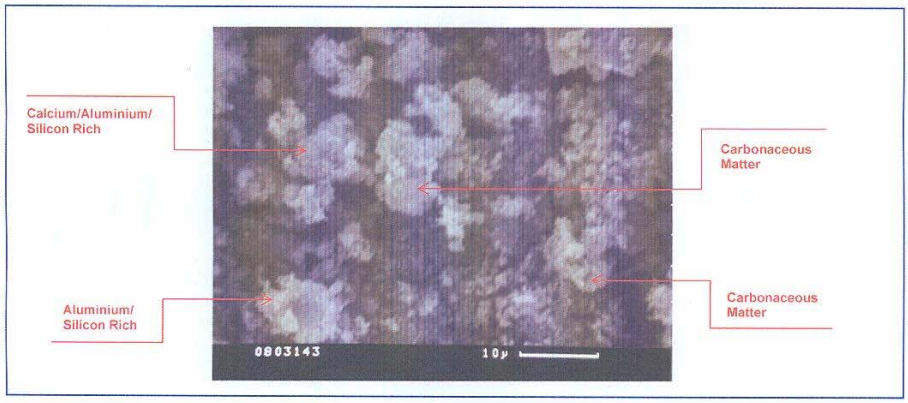
TEST REPORT

UKAS TESTING 1205

OCCUPATIONAL HYGIENE & ENVIRONMENTAL MONITORING LABORATORY

RESULTS OF EXAMINATION BY SEM-EDS

Mr A M Irving States of Jersey Health Protection, Public Health Services Le Bas Centre St Saviours Rd St Helier Jersey JE1 4HR	**Report Number:** **Job Number:** **Date Received:** **Date Analysed:** **Sample Description:** **TES Sample ID Number:** **Issue Date:** **Page:**	ED/AD/18080/SEM/0001, Rev. 0 ED/AD/18080 02 April 2008 08 April 2008 Glass Fibre filter: Central Market Roof ED/AD/0803143 23 April 2008 1 of 1



Identification of Dust Gauge / Environmental Deposits by SEM/EDS Method Number SEMDG7

Forty particles were analysed individually; the results are shown below.

Category	Estimated %	Category	Estimated %	Category	Estimated %
Carbonaceous matter	55	Sodium/Chlorine rich[$]	20	Animal/plant fragment	10
Aluminium/Silicon rich	7	Calcium/Aluminium/ Silicon rich	8		

[$] *This suggests sodium chloride (salt) is present.*
The other mineral particles may be classified as general dirt.

The examination procedure is based on an assessment of 40 individual particles selected at random.
The estimated percentage is based on a comparison of the relative number of particles counted in each category.

TES Bretby does not accept responsibility for the sampling associated with the results reported above.
Opinions and interpretations expressed herein are outside the scope of our UKAS accreditation.

Authorised by: D Cowper

D A Cowper, SEM Senior Analyst
Direct Dial: 01 283 554462

- END OF REPORT -

TES Bretby, P.O.Box 100, Burton-on-Trent, DE15 0XD Telephone: 01283 554400 Fax: 01283 554422
BSI Registration Nos: FS 75748, EMS 511803

TES Bretby is a trading name of Environmental Services Group Limited
Registered office: Askern Road, Carcroft, Doncaster, South Yorkshire DN6 8DG Registered in England no. 2880501
www.tes-bretby.co.uk

b. Havre Des Pas

TES Bretby

TEST REPORT

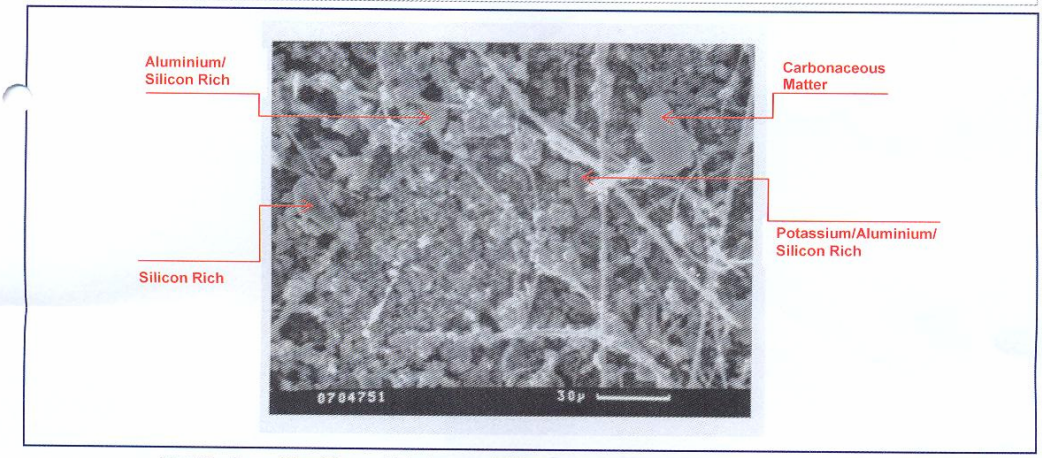
UKAS TESTING 1205

OCCUPATIONAL HYGIENE & ENVIRONMENTAL MONITORING LABORATORY

RESULTS OF EXAMINATION BY SEM-EDS

Mr J Fail
States of Jersey
Health Protection, Public Health Services
Le Bas Centre
St Saviours Rd
St Helier
Jersey
JE1 4HR

Report Number:	ED/AD/17144/SEM/0001, Rev. 0
Job Number:	ED/AD/17144
Date Received:	02 July 2007
Date Analysed:	17 July 2006
Sample Description:	Glass Fibre filter: Havre Des Pas, Old Dela Place Hotel
TES Sample ID Number:	ED/AD/0704751
Issue Date:	23 July 2007
Page:	1 of 1



Identification of Dust Gauge / Environmental Deposits by SEM/EDS Method Number SEMDG7

Forty particles were analysed individually; the results are shown below.

Category	Estimated %	Category	Estimated %	Category	Estimated %
Carbonaceous matter	23	Iron rich	2	Silicon rich	15
Aluminium/Silicon rich	12	Potassium/Aluminium/ Silicon rich	15	Animal/plant fragment	15
Sodium/Chlorine[$]	18				

[$] *This suggests sodium chloride (salt) is present.*
The other mineral particles may be classified as general dirt.

The examination procedure is based on an assessment of 40 individual particles selected at random.
The estimated percentage is based on a comparison of the relative number of particles counted in each category.

TES Bretby does not accept responsibility for the sampling associated with the results reported above.
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Authorised by: D Cowper

D A Cowper, SEM Senior Analyst
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Registered office: Askern Road, Carcroft, Doncaster, South Yorkshire DN6 8DG Registered in England no. 2880501
www.tes-bretby.co.uk

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