



**Report to:** Rochdale Borough Council

**Title:** Monitoring of airborne asbestos fibres  
around the Turner Brothers Asbestos site.

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*Move Forward with Confidence*



## Document Control Sheet

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## Executive Summary

The Turner Brothers Asbestos (TBA) site at Spotland lies within the geographic area covered by Rochdale Borough Council (BC) and is situated in Spodden valley. The site was founded in 1871 and has a long history of the manufacture of asbestos containing materials and products and was at one time the world's largest asbestos textile factory. The principal asbestos type utilised at the site is understood to be chrysotile (white asbestos).

The site was purchased by Federal-Mogul in 1998; in 2001 the UK business went into administration with demolition of several parts of the site undertaken the same year.

Previous investigation of the site and its surroundings has revealed evidence of contamination in parts of the woodland and other areas of the site. Woodland areas were found to have asbestos contamination within the ground in which trees have rooted and are maturing, with subsequent risk of disturbing asbestos, particularly following any events causing trees to 'uproot'.

Major fires occurred at the site in 2013 and 2014 which resulted in structural damage to the buildings with the potential for the release of asbestos fibres from the roofing and cladding materials etc. used on the site, the fire damaged buildings were demolished after the incidents.

Air monitoring was conducted at approximately monthly intervals from August 2015 to March 2017 at monitoring locations surrounding the site. The monitoring locations were identified by Rochdale BC in agreement with Bureau Veritas after considering factors including prevailing wind direction, ease of access and willingness of residents to host a monitoring station. Samples were analysed by Phase Contrast Optical Microscopy (PCOM) initially, with duplicate samples taken simultaneously which were used as an archive from which to select samples for analysis by Scanning Electron Microscopy.

None of the filter samples analysed by PCOM gave a result above the reporting limit of the method (all were <0.01 fibres/ml).

Selected samples from the duplicate sets were analysed by SEM. The decision as to which samples were submitted for analysis was based on the number of fibres observed in the PCOM analysis and the wind direction on the day of sampling.

None of the filter samples analysed by SEM in phase 1 of the survey gave a result above the reporting limit of the method (all were <0.001 fibres/ml). One amphibole asbestos fibre was identified by SEM in the sample taken at Harridge Avenue on 16th February 2016, amphibole asbestos includes amosite and crocidolite (brown and blue asbestos). The TBA factory primarily processed chrysotile, also known as white asbestos, this belongs to the serpentine class of minerals, however previous investigations have identified both amosite and crocidolite in areas of the site. The detection limit of the SEM procedure is statistically calculated to be less than the concentration equivalent to three fibres, as discussed in Section 6.2.

The sample obtained from the Broadlea Grove site in June 2016 as part of the phase 2 survey gave a positive result (0.0014 fibres/ml); all of these fibres were identified by SEM as man-made mineral fibre. Man-made mineral fibres were also identified in the samples from Fallowfield Drive taken in February 2017 and Harridge Avenue taken in March 2017. Man-made mineral fibres are typically used for insulation purposes and are not carcinogenic. The Workplace Exposure Limit for man-made mineral fibres is defined in terms of a fibre count (2 fibres/ml as an 8 hour Time Weighted Average exposure) and a gravimetric concentration (5mg/m<sup>3</sup> as an 8 hour Time Weighted Average exposure).



No asbestos fibres were identified in any samples analysed as part of phase 2 of the survey, this included samples taken from the same Harridge Avenue site in June 2016 and March 2017. Twice as many fields were examined by SEM in Phase 2 of the survey compared with phase 1 which increased the sensitivity of the method.

## 1. Introduction

The Turner Brothers Asbestos (TBA) site at Spotland lies within the geographic area covered by Rochdale BC and is situated in Spodden valley. The site consists of a developed area containing former production and administrative buildings, hardstanding areas plus woodland located to the east, south and north of the site. The site is divided roughly 50:50 between hard standing and woodland areas having approximately 36 acres of each (total approximately 72 acres).

The river Spodden passes through the west and south of the developed area.

Outside the site there are substantial residential areas situated on all boundaries apart from the South West.

The site was founded in 1871 and has a long history of the manufacture of asbestos containing materials and products and was at one time the world's largest asbestos textile factory. The principal asbestos type utilised at the site is understood to be chrysotile (white asbestos). The site was purchased by Federal-Mogul in 1998. In 2001 the UK business went into administration with demolition of several parts of the site undertaken the same year.

Previous investigation of the site and the surrounding woodland has revealed significant contamination in parts of the woodland and other areas of the site. Woodland areas were found to have asbestos contamination within the ground in which trees have rooted and are maturing, with subsequent risk of disturbing asbestos, particularly following any events causing trees to uproot.

In February 2013 a significant fire occurred at the site damaging several buildings. Asbestos was found to be present in the factory buildings involved in the fire but fire crews deemed it to be safely contained under the metal sheeting used in the construction. There are no reports available of any monitoring having been done at the time.

In January 2014 a second significant fire occurred at the site, again damaging several buildings. Air monitoring for asbestos fibres was conducted by Bureau Veritas in the vicinity of the site and concentrations were found to be below the limit of detection of 0.01fibres/ml.

Given the presence of asbestos contamination within this former industrial site and its proximity to residential areas, Rochdale BC requested Bureau Veritas to conduct a long term monitoring survey for airborne asbestos fibres to assess the impact of the site and its potential to release fibres into the environment off the site during normal conditions and during abnormal incidents such as fire, severe weather, demolition, tree fall or other situations.

Bureau Veritas has a long established asbestos consultancy division and carries all the appropriate accreditations for asbestos work.

The survey commenced in August 2015, with sampling conducted on a monthly basis, where weather conditions permitted, to provide a reliable year round background fibre count record. The air monitoring work concluded in March 2017.

## 2. Scope of Works

Works were carried out in accordance with BV proposal reference UK.1585161/v2.

The objective of the assessment requested by Rochdale BC was to establish the presence and concentration of airborne asbestos fibres in the environs of the former TBA site at Spotland, and subsequently whether an asbestos hazard to local residents and the public could be recognised. The assessment process proposed and discussed with Rochdale BC involved a phased approach consisting of an initial fact finding and pilot sampling study followed by a data collection phase based on the findings of the preliminary assessment.

Accurate & reliable measurement of atmospheric asbestos over time requires the establishment of suitable sampling stations located in representative locations surrounding the site boundary.

### 2.1 Rationale for choosing sampling locations

The prevailing wind direction is from the south west but in spring there can be a high frequency of north to north easterly wind directions (source: Met office). Monitoring was undertaken once a month, the met office weather forecast was analysed to identify the optimum day for undertaking the monitoring.

It was decided to establish four permanent monitoring stations around the site, with one control station situated at the council offices in Rochdale town centre. Provision was also made to take additional ad-hoc samples if weather conditions were suitable and if previous samples indicated a problem or if site disturbance was evident. These additional sampling locations were to be decided on the day of monitoring with their position dependant on the prevailing weather conditions.

The position of the permanent and variable monitoring stations were chosen on the basis of the quality of the data which they could provide on the long term exposure of fibres from the site, ease of access and willingness of neighbouring residents to host a monitoring station.

The source-pathway-receptor contaminant linkage was considered in deciding the best locations for the monitoring stations:

| <b>Sources</b>  | <b>Pathway</b>   | <b>Receptors</b>  |
|---|------------------|---|
| The former factory buildings and areas where dumping was known to be undertaken | Windblown fibres | Humans living within the residential properties and using the school, public paths and playground |

The main residential area is situated to the north east of the site, in the direction of the south westerly prevailing winds; however the direction of wind is often towards other areas. Should the direction of the wind on the day of monitoring be in another direction than from the south west then the data it provided would be limited.

Therefore since the resources had to be targeted to be most effective it was decided not to site a permanent station in this area but a property was identified which agreed to be a variable location to be used when the wind direction was from the south west.

### Rationale for permanent monitoring stations

A permanent control station was set up at the Rochdale Council Offices approximately 1.7km south east of the site, the area around the offices are mostly commercial and industrial with some residential areas. This was therefore considered a reasonable comparison to the area around the TBA site.

Table 1: Permanent Monitoring Stations (see photographs in Appendix 1)

| Location                        | Reason   | Distance from the site               |
|---------------------------------|--|--------------------------------------|
| <b>Falings Park High School</b> | Large number of children therefore sensitive and closest area of buildings in the south east of the site. Weather station also situated at this location   | Approximately 290m SE of site        |
| <b>Royds Arms public house</b>  | In spring wind direction can be from the NE, Royds Arms ideally located for sampling   | Immediately to the south of the site |
| <b>Broadlea Grove</b>           | Ideally situated for when wind is from the south   | Immediately north of the site        |
| <b>Harridge Avenue</b>          | Properties on Dell Road and Harridge Avenue were approached and the council received a number of offers, Harridge Avenue was selected as it was ideally located to assess any fibre distribution from the known area of dumping. Furthermore if fibres were identified further variable sampling can be undertaken at the junction of Woodland and Dell Road to assess whether a contaminant linkage exists from the dumping area to the properties NE of the site | Approximately 420m north of the site |

### Rationale for variable monitoring stations

A number of sensitive locations were identified around the site that would have been useful for monitoring, these included, residential houses, an outdoor play area and public footpaths.

During the monitoring programme unauthorised dumping occurred on the TBA site, in the area between Woodland Road and the derelict factory buildings, sampling was undertaken on Woodland Road in positions close to this area to assess whether the material could contain material which may release fibres.

In April 2016, a number of samples were subject to analysis by SEM, this was undertaken to assess the effectiveness of the monitoring to date and to ensure the remaining monitoring was targeted effectively. This identified the presence of one asbestos fibre at the Harridge Avenue station, in response to this the number of variable sample points were increased as was the Limits of Detection (LOD) when it came to sample analysis.

Table 2: Variable Monitoring Stations

| Location                                  | Reason   | Distance from the site       |
|---|--|------------------------------|
| <b>Dell Play Area</b>                     | Used by children therefore sensitive, west of known dumping area, undertaken on a monitoring day after it had been identified the wind had been blowing from east to west for several days and the conditions had been dry   | Approximately 440m NW        |
| <b>Fallowfield Drive</b>                  | On the housing estate to the NE of site, monitored when the prevailing south westerly winds were blowing   | Immediately NE of site       |
| <b>Junction of Dell and Woodland Road</b> | Situated close to the area where dumping was known to have taken place on a public footpath. One asbestos fibre identified at Harridge Avenue therefore monitoring undertaken at this location to assess whether a contaminant linkage maybe present, these properties were known to contain ACM. No fibres identified at junction therefore source could probably be localized to the housing estate rather than the TBA site | Approximately 420m N of site |
| <b>Woodland Road</b>                      | A public footpath which passes through the centre of the site and close to where the unauthorised dumped material is situated  | Immediately W                |
| <b>Security Cabin</b>                     | Situated on Spod Road, south of the site, on some monitoring days it was not possible to use the Royds Arms due to works being undertaken there, also certain days were very still, little wind, therefore this location was the closest to the site   | Immediately S                |

## 2.2 Preliminary Sampling Exercise (Phase 1)

A trial sampling exercise / site familiarisation visit was carried out to assess the suitability of the suggested sites and to confirm that these were appropriate. Cabinets to hold the air sampling equipment were fixed to boundary fences / guard rails at the same time to ensure that future samples were taken in the exact same location. Filter samples taken on this initial visit were counted using the HSG248 reference method <sup>[Ref 1]</sup> by Phase Contract Optical Microscopy (PCOM), see section 3 for details of the methodology.

Note that the method of analysis by PCOM involves identifying fibres conforming to defined size and shape criteria and does not positively identify the fibres as asbestos. In addition sample obscuration of fibres by particulate matter (including smoke & diesel particulate for instance) could have rendered analysis by the PCOM method impossible. Where excess particulate is present making a slide uncountable or where there is a requirement to positively identify the fibres present as asbestos then analysis can be undertaken by scanning electron microscopy (SEM) however this method of analysis is more expensive than PCOM and would involve a longer analytical turnaround time as the samples would need to be analysed at a laboratory rather than on site. Analysis by SEM cannot be undertaken on filters that have already been prepared for counting by PCOM, hence the SEM process would have to be considered at the time of sample collection with either an additional sample taken or the filter cut into two.

The initial survey collected samples from the four permanent locations as described in Section 2.1 with the analysis being undertaken by a Bureau Veritas UKAS certified asbestos consultant (UKAS ref 1746). An additional set of samples was obtained at the control location in Rochdale town centre (The roof of the Library and council offices, Number One Riverside, Smith Street, Rochdale).

It was observed during the initial site visit that some of the properties on Broadlea Grove had asbestos cement soffits, as evidenced by a small fragment of asbestos cement board present in the gravel by the path alongside this property.

A meteorological monitoring station was used to collect local wind speed and direction data subsequent to the initial sampling period. The monitoring station was located on the roof of Falinge Park High School, corresponding with one of the permanent monitoring stations.

## 2.3 Long Term Data Collection (Phase 2)

The long term (Phase 2 strategy) was developed by Rochdale BC with advice from Bureau Veritas using the information from the initial sample rounds and other historical information and data, as described in Section 2.1.

The strategy considered the following

- a. Sample locations - based on prevailing wind conditions and airborne fibre concentrations determined as part of the initial phase of the survey – the choice of actual locations chosen depended upon the practical opportunities for siting and operating the equipment including security and access to the site.
- b. Sample volumes and times – based on the required detection limits, surveyor availability, pump battery capacity and sample quality (the presence of other particles that may obscure the viewable fields on the filter).
- c. Sampling frequency – planned as regularly spaced (monthly) sampling visits to collect samples over the course of one year to obtain representative air concentrations under a variety of weather conditions.
- d. Variations to the strategy – the overall strategy and the procedures for sample collection were reviewed on a regular basis and criteria for increasing or decreasing the sampling frequency or changing the methodology were established – these included:
  - i. At times of planned activities (demolitions, groundwork etc.).
  - ii. During periods of extended dry weather / inclement weather.
  - iii. Following changes to the site or incidents such as vandalism or fire.
  - iv. Where previous results are showing elevated or increasing fibre concentrations.
  - v. Following changes to legal limit values/guidelines.

During these periods Bureau Veritas would collect samples at an enhanced rate (weekly, daily etc.) or by following revised methodologies (such as use of SEM) as directed by Rochdale BC. The following events occurred during the course of the survey which required adjustment to the planned sampling frequency.

- i. A few months were missed due to prolonged bad weather preventing air monitoring or due to illness of the consultant attending site.
- ii. In July 2016 unauthorised dumping occurred on the TBA site, this is subject to an investigation by the Environment Agency who inspected the waste materials and judged them to be largely inert, however it was considered prudent to increase the number of variable sampling locations on Woodland Road immediately adjacent to these waste piles.
- iii. An intrusive ground investigation was conducted by the site owners own consultants (RSK Group) over the period November 2016 to January 2017, it was therefore decided to extend the phase 2 monitoring period to March 2017 to ensure any ground disturbances were covered.

## 3 Sampling Methodology

### 3.1 Sampling and Testing Methodology including Limits of Detection

#### 3.1.1 HSG248 – Phase Contrast Microscopy

Sampling and analysis was undertaken following the methodology set out in HSG248 [Ref 1] for the collection of asbestos fibres in air.

The standard method is to draw 480 Litres (8L/min for 60 minutes) of air through a mixed cellulose ester (MCE) filter which is subsequently cleared and analysed by phase contrast microscopy and the number of fibres meeting certain size and shape requirements are counted over a pre-defined area of the filter – usually 200 circular "fields" of diameter 100µm. This equates to a lowest level of reliable detection above background for the method of 0.01 fibres/ml of air.

In order to measure airborne fibres to a lower limit of detection it would be necessary to change the methodology by either

- a. Increasing the volume of air sampled by increasing the pump flow rate or the length of time spent sampling and/or increasing the number of fields counted by PCOM.
- b. Increasing the volume of air sampled and undertaking analysis by TEM.

Due to the prescriptive nature of our UKAS accreditation for reporting airborne fibres it was not possible to vary the pump flow rate or sampling time significantly to enable a lower detection limit to be reported.

An additional sample was therefore taken at each sampling location using an increased sample volume for analysis by SEM which would allow both a reduced limit of detection and the positive confirmation of asbestos fibres.

#### 3.1.2 Use of Scanning Electron Microscopy (SEM)

Method HSG248 allows for the inclusion in the total number of countable fibres of any fibre meeting defined size and shape criteria and does not specifically determine whether the fibre is asbestos or another type of fibre. Where countable fibres are noted by phase contrast microscopy (PCOM) it is possible to use SEM with Energy Dispersive X-Ray Spectroscopy (EDXS) to identify the type of fibre including whether or not the fibre is asbestos.

SEM may also be used where PCOM is not able to determine the fibre concentration for the sample, for example where the filter is obscured by smoke / soot particles.

The samples selected for SEM analysis were selected by Rochdale BC in consultation with Bureau Veritas.

Samples were analysed by the Institute of Occupational Medicine (IOM) Laboratory, Riccarton, Edinburgh. The analytical methodology is as follows:

Each membrane filter is ashed in a low temperature plasma asher. The residue from the plasma ashing is recovered using filtered, distilled water and filtered through a 25mm, 0.4µm pore size polycarbonate filter. A portion of each filter is excised and mounted on a 13mm aluminium stub, coated with gold and examined by SEM. Filters are searched systematically at 2000X magnification



until an area of 1mm<sup>2</sup> has been examined or 50 whole fibres found. All respirable fibres (aspect ratio >3:1, length >5µm and diameter <3µm and including fibres in contact with particles >3µm diameter) detected are analysed by EDXS and identified as closely as possible, by comparing morphology and composition with standard reference materials.

The method used for analysis is documented in IOM instruction manual No.1 and is based on Asbestos International Association, Recommended Technical Method No. 2 (RTM2, AIA 1984) <sup>[Ref 7]</sup> and International Standards Organisation (2002), International Standard 14966 <sup>[Ref 8]</sup>.

## 4 Health Effects

### 4.1. Introduction

Asbestos is a common name for a group of mineral silicates which exist in an 'asbestiform' habit, that is to say that they occur in polyfilamentous bundles composed of flexible fibres. The two main types are:

- the amphiboles, which include amosite (brown asbestos), crocidolite (blue asbestos) and tremolite
- serpentine asbestos, also known as chrysotile or white asbestos

Asbestos-containing materials (ACMs) are found commonly in buildings constructed up to the year 2000 as floor and ceiling tiles, pipe lagging, insulation board, roofing materials, protective coatings, textured decorations, etc., as well as being widely used as brake linings. This has inevitably led to asbestos fibres being liberated into the air, eg. from damaged and/or weathered surfaces and there is generally a small amount of airborne asbestos present in the urban environment (see Table 3).

Background ambient levels of respirable asbestos fibres may range in urban areas from below 0.0001 fibres per millilitre (f/ml) to 0.001 f/ml. Assuming a respiratory rate of 8 litres (l)/minute, the Medical Research Council (MRC) Institute for Environmental Health estimated that this level of exposure would result in a lifetime exposure to asbestos fibres in the range of 0.29 million to 29.5 million fibres.

Table 3: Airborne levels of asbestos

| Air concentration (f/m <sup>3</sup> ) | Equivalent air concentration (f/ml) | Meaning  |
|---------------------------------------|-------------------------------------|--|
| 100,000                               | 0.1                                 | HSE 4-hour control limit (Control of Asbestos Regulations 2012) <sup>[Ref 2]</sup> |
| 10,000                                | 0.01                                | HSE 'clearance indicator' level <sup>[Ref 2]</sup>                                 |
| 1,000                                 | 0.001                               | WHO air quality guideline* <sup>[Ref 3]</sup>                                      |
| 100 – 1,000                           | 0.0001 – 0.001                      | Background levels in typical urban environment                                     |

\* Measured by electron microscopy

### 4.2. Health Effects <sup>[Ref 12]</sup>

The main non-carcinogenic health effects in humans associated with exposure to asbestos exposure to asbestos are diffuse pleural thickening (DPT), pleural plaques, asbestosis (fibrosis) and decrease in lung function.

Asbestosis is a serious scarring condition of the lung that normally occurs after heavy exposure to asbestos over many years. This condition can cause progressive shortness of breath, and in severe cases can be fatal.

Pleural thickening is generally a problem that happens after heavy asbestos exposure. The lining of the lung (pleura) thickens and swells. If this gets worse, the lung itself can be squeezed, and can cause shortness of breath and discomfort in the chest.

In respect of carcinogenic effects, a recent International Agency for Research on Cancer (IARC) review has concluded that 'all forms of asbestos (chrysotile, crocidolite, amosite, tremolite, actinolite and anthophyllite) are carcinogenic to humans (Group 1)' and that 'asbestos causes mesothelioma and cancer of the lung, larynx, and ovary'.

Mesothelioma is a cancer which affects the lining of the lungs (pleura) and the lining surrounding the lower digestive tract (peritoneum). It is almost exclusively related to asbestos exposure and by the time it is diagnosed, it is almost always fatal.

Asbestos-related lung cancer is the same as (looks the same as) lung cancer caused by smoking and other causes. It is estimated that there is around one lung cancer for every mesothelioma death. In addition, IARC concluded that 'positive associations have been observed between exposure to all forms of asbestos and cancer of the pharynx, stomach, and colorectum'.

The main factors determining the health effects of asbestos fibres are its form, type, size, surface chemistry, biopersistence and solubility in body fluids. Fibres need to be sufficiently long, thin and durable' to exert pathogenic effects and this means meeting the World Health Organization (WHO) fibre definition, i.e.:

- an aspect ratio  $\geq 3 : 1$
- length  $\geq 5 \mu\text{m}$
- diameter  $\leq 3 \mu\text{m}$

Generally, the pathogenic potency increases with fibre length, but the smaller fibres still have a role to play in determining health effects. Other factors also play a part and these includes trace contaminants, solubility in body fluids and ability to translocate through body tissues. Differing physical structures result in amphiboles and serpentine asbestos behaving differently within human tissues. Chrysotile asbestos is formed as rolled concentric cylindrical sheets which can be readily degraded into smaller fibrils which can be easily removed from the body. The amphiboles exist as twin sheets formed into solid cylinders which are much more resistant to degradation in the body than chrysotile. The amphiboles tend to break along the crystal planes forming smaller, thinner fibres, which still retain pathological properties.

## 5 Human Health Risk Assessment

### 5.1. Risk assessment of low level environmental exposures <sup>[Ref 6]</sup>

Risk assessment terminology in respect of asbestos exposure usually refers to an air concentration in terms of numbers of fibres/ml.years, for example an exposure to 25 fibres/ml.years could be equivalent to 25 years at 1 fibre/ml, 10 years at 2.5 fibres/ml or 1 year at 25fibre/ml.

Background cumulative public exposure to asbestos is likely to be less than 0.01 f/ml.y. This could arise from exposure to urban background levels of 0.0001 f/ml, experienced for several decades. Short-term exposure to a low level of asbestos, for instance a contamination incident where the public might experience a concentration of 0.1 f/ml for several hours over possibly one or a few days (this would be equivalent to less than 0.01 working year), could result in an even smaller cumulative load (ie 0.001 f/ml.y in this example) than is experienced from background exposure.

Due to the absence of a threshold for the carcinogenic effects of all forms of asbestos, a small risk to public health may be present at these low level environmental asbestos exposures. The risk model published by Hodgson and Darnton allows an estimate of cancer risk to be made at exposure levels which are much lower than those experienced in the epidemiological studies, where exposures were in the range of 100–1000 f/ml.y. The Hodgson and Darnton risk estimates, extrapolated down to 0.1 f/ml.y, are presented in Table 4. There is considerable uncertainty in the risk estimates as can be seen in the wide ranges given in brackets at the lower exposure levels in the table. It should be born in mind that these lower estimates are highly uncertain as these cumulative exposures are up to 100,000 times lower than the observable data range from which dose-response relationships were obtained. Consequently, numbers should not be used as an absolute risk estimate, but rather as an ‘indicator’ of relative risks.

Table 4: Hodgson and Darnton risk estimates – excess lifetime asbestos-related lung cancer and mesothelioma (the two tumour types combined) per 100,000

| Exposure (f/ml per year) | Crocidolite<br>( best )<br>( max–min* ) | Amosite<br>( best )<br>( max–min* ) | Chrysotile<br>( best )<br>( max–min* ) |
|--------------------------|---|-------------------------------------|--|
| 10                       | 5600<br>(3200 – 8400)                   | 2300<br>(960 – 4000)                | 56<br>(23 – 340)                       |
| 1                        | 750<br>(250 – 1600)                     | 180<br>(35 – 570)                   | 6<br>(1 – 45)                          |
| 0.1                      | 120<br>(24 – 360)                       | 21<br>(2 – 100)                     | 1<br>(0.1 – 7)                         |

\* Best estimate from the Hodgson and Darnton 2000 best-slope model with maximum and minimum estimates based on the range of predictions consistent with the Hodgson and Darnton 2000 high-slope and low-slope models. All models give cumulative risk up to age 80. Risks calculated for 5 years’ exposure from age 30 years, calculated to age 80. These numbers should not be taken to be reliable absolute risk values.

Some national authorities consider an excess lifetime cancer risk of 1 in 100,000 to be broadly acceptable. This level of risk would equate to a cumulative exposure of 0.1 f/ml.y for chrysotile. Risks from the amphiboles at this exposure level may be substantially higher.

The HSE's advisory body, the Working Group on Action to Control Chemicals (WATCH) <sup>[Ref 5]</sup>, reviewed the applicability of using Hodgson and Darnton risk estimates at lower levels than published in Table 4, and concluded:

*'... the scientific judgement of WATCH is that there are risks of asbestos-induced cancer arising from work-related cumulative exposures below 0.1 fibres/ml.years. ...*

*'The risk will be lower, the lower the exposure, but 'safe' thresholds are not identifiable. ...*

*'Where potential exposures to amphiboles, particularly crocidolite, are below 0.1 fibres/ml.years (for example, 0.01 fibres/ml.years), the available scientific evidence suggests no basis for complacency, but rather a basis for active risk management ...'*

## 5.2. Exposures in childhood <sup>[Ref 15]</sup>

The risk model for mesothelioma (but not for lung cancer) is not simply based on cumulative exposure (f/ml.y) but is also dependent on time elapsed since first exposure. The risk calculations in Table 4 assume a 50-year period since first exposure for adults. Children exposed to asbestos have potentially a longer time since first exposure, compared to adults, and so are at greater risk for the same level of fibre exposure. The important aspect of possible increased vulnerability of children has been considered by the UK Government's Advisory Committee on Carcinogenicity (CoC) which concluded:

*'From the available data, it is not possible to say that children are intrinsically more susceptible to asbestos related injury.*

*'However, it is well recognised by this Committee that, due to the increased life expectancy of children compared to adults, there is an increased lifetime risk of mesothelioma as a result of the long latency period of the disease.*

*'In reaching our conclusion and taking into consideration that there are a number of uncertainties and data gaps, we conclude that exposure of children to asbestos is likely to render them more vulnerable to developing mesothelioma than exposure of adults to an equivalent asbestos dose.'*

One of the sensitive receptor groups identified in the area is Falinge Park High School which is an 11–16 mixed comprehensive school and which has been selected as one of the monitoring locations (South East of the site). Little Steps Nursery School on Tenby Street is the closest preschool location to the site; this is in a similar location to the Royds Arms on Rooley Moor Road (South of the site).

Table 5 provides a relative risk calculation for children compared to adults based on an increased duration of exposure. Compared to an adult first exposed at age 30 years, a child with the same cumulative exposure of 0.1 f/ml.y, with exposure beginning age 5, carries a 5.3 times greater risk of mesothelioma. Risk estimates which involve early life exposures need to be multiplied by adjustment factors such as those given in Table 5 (abstracted from data provided in Ref 15).

Table 5: Age adjustment factors for mesothelioma risk dependent on the age at which exposure commences

| Age at start of exposure | Risk persisting until age 80 |
|--------------------------|------------------------------|
| 0                        | 7.0                          |
| 5                        | 5.3                          |
| 10                       | 4.0                          |
| 15                       | 3.0                          |
| 20                       | 2.1                          |
| 25                       | 1.5                          |
| 30                       | 1                            |
| 40                       | 0.4                          |

N.B. these factors make no adjustment for possible greater susceptibility of the young.

In addition to the greater risk due to early life exposures, children might also be more susceptible to early age exposures to asbestos, potentially because of impaired clearance mechanisms, underdeveloped immune systems, greater exposures relative to body weight, presence of actively growing tissues, etc. This is an important factor that needs to be considered in public health risk assessments of environmental asbestos exposure.

### 5.3. A risk assessment approach to low level environmental exposures

The Hodgson and Darnton risk model and the caveats described by WATCH and CoC provide an approach which might be useful for evaluating low level asbestos exposures (for example prolonged low exposure from asbestos-contaminated soils, short-term public exposure resulting from demolition work, or the discovery of asbestos in air at school premises). Placing these exposures into some context using the risk estimates can aid the public communication, prioritisation and management in these incidents.

The approach first requires an assessment of cumulative exposure in terms of f/ml.y. In this context a year is taken to be 1920 hours, the duration of a working year (or school year) on which the epidemiological evidence is based, not 8760 hours which is the number of hours in a year (365 days x 24 hours/day). Once a cumulative exposure in terms of f/ml.y has been calculated, an adjustment may need to be made for early life exposures if relevant. The HSE WATCH table (Table 4) can be consulted to give an indication of risk if the type of fibre involved in the exposure is known. If exposures are to chrysotile and are well below 0.1 f/ml.y, risks are possibly so small that they may not be significant<sup>[Ref 6]</sup>. However, exposures to other types of asbestos greater than 0.1 f/ml.y may indicate that a more detailed risk assessment and/or mitigation measures may be required, hence the establishment of this monitoring framework.

## 6 Monitoring Results

### 6.1. Phase Contrast Optical Microscopy Results

The airborne concentrations of respirable fibres using the fibre count method yielded **no results above the analytical limit of detection (0.01 f/ml)**.

Summary tables showing the number of countable fibres / objects on the filters is provided in tables 6 – 8 below.

Duplicate samples were taken at each location with one sample analysed by PCOM and one reserved for SEM, if necessary. Samples were not taken in May, August, September 2016 and January 2017.

Table 6. Monitoring results summary 2015 (numbers of “fibres” observed in 200 fields)

| Site address                  | 24/08/15 | 16/09/15 | 22/10/15 | 04/12/15 |
|-------------------------------|----------|----------|----------|----------|
| Wind direction (wind from...) | No data  | NNE      | SW       | S        |
| Wind speed (m/s)              | No data  | 1        | 8        | 7        |
|                               |          |          |          |          |
| Harridge Avenue               | 1        | 1        | 1        | 2        |
| Broadlea Grove                | 0.5      | 1        | 1        | 2.5      |
| Falinge Park High School      | 1        | 1        | 2        | 3.5      |
| Royds Arms                    | 0        | 0.5      | 1.5      | 2        |
| 1 Riverside                   | 0.5      | 0        | 1.5      | 1.5      |
| Fallowfield Drive             | -        | -        | -        | 1.5      |
| T&N Security cabin            | -        | -        | -        | -        |

Table 7. Monitoring results summary 2016 (numbers of “fibres” observed in 200 fields)

| Site address                  | 13/01/16 | 16/02/16 | 16/03/16 | 13/04/16 | 05/16 | 21/06/17 |
|-------------------------------|----------|----------|----------|----------|-------|----------|
| Wind direction (wind from...) | S / SSW  | SSE      | NNE      | S/SW     |       | S        |
| Wind speed (m/s)              | 10       | 6        | 4        | 3        |       | 4        |
|                               |          |          |          |          |       |          |
| Harridge Avenue               | 0.5      | 0.5      | 0        | 0.5      | -     | 1        |
| Broadlea Grove                | 1        | 0        | 1.5      | 0.5      | -     | 1        |
| Falinge Park High School      | 0        | 1        | 1        | 0        | -     | 0        |
| Royds Arms                    | 1        | 1        | 3        | 0.5      | -     | 0        |
| 1 Riverside                   | 0        | 0        | 1        | 0        | -     | 0        |
| Fallowfield Drive             | -        | 1        | -        | 0        | -     | 0.5      |
| T&N Security cabin            | 0        | -        | -        | -        | -     | -        |
| Playground                    | -        | -        | 0        | -        | -     | -        |
| Woodland Road                 | -        | -        | -        | -        | -     | 0        |

Table 7 (cont). Monitoring results summary 2016 (numbers of “fibres” observed in 200 fields)

| Site address                  | 19/07/16 | 08/16 | 09/16 | 12/10/16 | 23/11/16 | 07/12/16 |
|-------------------------------|----------|-------|-------|----------|----------|----------|
| Wind direction (wind from...) | ESE      |       |       | ENE      | ENE      | SW       |
| Wind speed (m/s)              | 2        |       |       | -        | 2        | 6        |
| Harridge Avenue               | 0        | -     | -     | 0.5      | 0        | 0        |
| Broadlea Grove                | 1        | -     | -     | 0.5      | 0.5      | 0        |
| Falinge Park High School      | 0.5      | -     | -     | 0        | 0        | 0        |
| Royds Arms                    | 0        | -     | -     | 0        | 0        | 0        |
| 1 Riverside                   | 1        | -     | -     | 0        | 0.5      | 0        |
| Fallowfield Drive             | 1        | -     | -     | 0.5      | 0        | 0.5      |
| T&N Security cabin            | 0.5      | -     | -     | -        | -        | -        |
| Playground                    | -        | -     | -     | -        | -        | -        |
| Woodland Road                 | 0.5      | -     | -     | 1.5      | 0        | 0.5      |

Table 8. Monitoring results summary 2017 (numbers of “fibres” observed in 200 fields)

| Site address                       | 01/17 | 01/02/17 | 21/02/17 | 15/03/17 |
|------------------------------------|-------|----------|----------|----------|
| Wind direction (wind from...)      |       | ENE      | SW       | SW       |
| Wind speed (m/s)                   |       | 2        | 3        | 4        |
| Harridge Avenue                    | -     | 0        | 0        | 0.5      |
| Broadlea Grove                     | -     | 0        | 0.5      | 0        |
| Falinge Park High School           | -     | 0        | 0        | 0        |
| Royds Arms                         | -     | 0.5      | 0        | 1.5      |
| 1 Riverside                        | -     | 1        | 1        | 1        |
| Fallowfield Drive                  | -     | 0.5      | 0.5      | 0        |
| T&N Security cabin                 | -     | -        | -        | -        |
| Playground                         | -     | -        | -        | -        |
| Woodland Road                      | -     | 0        | 0        | 0        |
| Dell Road / Woodland Road junction | -     | -        | 0        | -        |

“Fibres” (ie objects meeting the definition of a fibre) were identified on several filters however it is not possible to positively identify these “fibres” as asbestos using the fibre counting technique.

The meteorological data obtained from the roof of Falinge Park High School has confirmed the general historical trend of a prevailing wind from the South / South West, thus sampling locations towards the North / North East of the site would be anticipated to be most likely to receive any asbestos fibres released from the site.

## 6.2. Scanning Electron Microscopy Results

A summary table showing the number of respirable fibres identified on the filter samples collected during the initial phase of the survey is provided in table 9 below.

Table 9. SEM Monitoring results summary – phase 1

| Sample <sup>(1)</sup>       | Volume (litres) <sup>(1)</sup> | Resp. Fibres Found | No. of Fields Searched | Total Fibre Conc <sup>n</sup> (f/ml) | Asbestos Fibre Conc <sup>n</sup> (f/ml) |
|-----------------------------|--------------------------------|--------------------|------------------------|--------------------------------------|---|
| Falinge School<br>22/10/15  | 1203                           | 0                  | 150                    | ND <0.001*                           | ND <0.001*                              |
| Broadlea Grove<br>13/01/16  | 738                            | 0                  | 150                    | ND <0.001*                           | ND <0.001*                              |
| Royds Arms<br>16/03/16      | 780                            | 0                  | 150                    | ND <0.001*                           | ND <0.001*                              |
| Harridge Avenue<br>16/02/16 | 744                            | 1                  | 150                    | ND <0.001*                           | ND <0.001*                              |
| Blank                       | 0                              | 0                  | 150                    | -                                    | -                                       |

ND-None Detected

When no fibres of a given type are detected, the fibre concentration can be reported as less than the concentration equivalent to three fibres (the one sided upper 95% confidence limit of the Poisson distribution). Therefore, when 0, 1 or 2 fibres are detected, 2.99 is used in the calculation of fibre concentrations. It expresses the 95% confidence detection limit for airborne fibre concentrations. When a volume of 738 litres is used, the 95% confidence limit is 0.001 f/ml for the number of fields searched.

A single amphibole asbestos fibre was detected during the analysis of the sample labelled Harridge Avenue. No asbestos fibres were detected during the analysis of any of the other samples.

Any organic fibres present on the original sample would be destroyed during plasma ashing.

<sup>(1)</sup> The determination of number of asbestos fibres on the filter is UKAS accredited but since the sampling work is not under the direct control of the laboratory then it is not possible to give a wholly UKAS accredited result.

A summary table showing the number of respirable fibres identified on the filter samples collected during the second phase of the survey is provided in table 10 below. In view of the single asbestos fibre detected in the phase 1 survey and in order to reduce the detection limit still further the laboratory was requested to double the number of fields counted.

Table 10 SEM Monitoring results summary – phase 2

| Sample <sup>(1)</sup>                             | Volume (litres) <sup>(1)</sup> | Resp. Fibres Found | No. of Fields Searched | Total Fibre Conc <sup>n</sup> (f/ml) | Asbestos Fibre Conc <sup>n</sup> (f/ml) |
|---|--------------------------------|--------------------|------------------------|--------------------------------------|---|
| Broadlea Grove<br>21/06/16                        | 818.4                          | 9.5 <sup>(2)</sup> | 300                    | 0.0014                               | ND <0.0005*                             |
| Harridge Avenue<br>21/06/16                       | 871.2                          | 0                  | 300                    | ND <0.0005*                          | ND <0.0005*                             |
| Falinge School<br>19/07/16                        | 1059.1                         | 0                  | 300                    | ND <0.0004*                          | ND <0.0004*                             |
| Site Security Office<br>19/07/16                  | 732                            | 0                  | 300                    | ND <0.0005*                          | ND <0.0005*                             |
| Woodland Road<br>12/10/16                         | 744                            | 0                  | 300                    | ND <0.0005*                          | ND <0.0005*                             |
| Royds Arms<br>23/11/16                            | 756                            | 0                  | 300                    | ND <0.0005*                          | ND <0.0005*                             |
| Fallowfield Drive<br>07/12/16                     | 732                            | 0.5 <sup>(2)</sup> | 300                    | <0.0005*                             | <0.0005*                                |
| Royds Arms<br>01/02/17                            | 744                            | 0                  | 300                    | ND <0.0005*                          | ND <0.0005*                             |
| Fallowfield Drive<br>21/02/17                     | 732                            | 0                  | 300                    | ND <0.0005*                          | ND <0.0005*                             |
| Broadlea Grove<br>21/02/17                        | 756                            | 0                  | 300                    | ND <0.0005*                          | ND <0.0005*                             |
| Harridge Avenue<br>15/03/17                       | 744                            | 1 <sup>(2)</sup>   | 300                    | <0.0005*                             | <0.0005*                                |
| Woodland Road /<br>Dell road junction<br>15/03/17 | 748                            | 0                  | 300                    | ND <0.0005*                          | ND <0.0005*                             |

ND-None Detected

The detection limit (95% confidence limit) calculation is given in the text accompanying table 10. When a volume of 1059.1 litres is used, the 95% confidence limit is 0.0004 f/ml for the number of fields searched

- (1) The determination of number of asbestos fibres on the filter is UKAS accredited but since the sampling work is not under the direct control of the laboratory then it is not possible to give a wholly UKAS accredited result.
- (2) The fibres detected on the samples from Broadlea Grove (21/06/17), Fallowfield Drive (07/12/06) and Harridge Avenue (15/03/17) were all identified as Man Made Mineral Fibre (MMMF)

No asbestos fibres were detected during the analysis of any of the phase 2 samples. Any organic fibres present on the original sample would be destroyed during plasma ashing.

## 7 Comparison with data from similar locations within the UK

### 7.1. Armley, Leeds

Founded in Armley, Leeds in 1874, J. W. Roberts Limited was a textile producer based at the Midland Works on Canal Road. In 1906, the factory had begun manufacturing asbestos insulation mattresses and boiler linings, the mattresses were used for lining the bulkheads of ships as well as steam locomotive boilers. In 1920, J. W. Roberts Ltd merged with several other asbestos manufacturers including the Turner Brothers Asbestos Company to form Turner & Newell and by 1925 they became a public company.

The Roberts factory closed in 1959 and the site has since been redeveloped, however it would be anticipated to have had a similar impact on the surrounding area as the TBA site in Rochdale due to the nature of the factory process, the type of asbestos fibre involved and its location in the industrial / urban landscape.

The area surrounding the Armley site, including the Aviary housing estate, has been the subject of several studies, the most recent of which is Research Report TM/01/06, published by the Institute of Occupational Medicine in November 2001 <sup>[Ref 9]</sup>.

The report commented on the fact that there were three other factories located within about 400 metres of the old Roberts factory and a further six within 1600 meters which may have contributed to the contamination found within the properties in the surrounding areas.

Thirteen samples were obtained from houses under normal occupancy in the wider area outside the Aviary estate. No asbestos fibres were found on any of these samples – the concentration of asbestos fibres measured by TEM (Transmission Electron Microscopy) ranged from less than 0.0008 fibres/ml to less than 0.0002 fibres/ml (the range of detection limits quoted is due to variations in the sample volumes collected).

From this data an estimate of the maximum possible asbestos exposure level in such circumstances would be 0.00001 fibres/ml (this exposure level is calculated from the aggregation of data from all of the samples collected during the investigation, in which no asbestos fibres were identified). This compares with data reported by the Medical Research Council Institute for Environment and Health which suggested that in buildings where there were asbestos containing products in good condition the exposure levels were generally less than 0.0005 fibres/ml and outdoors in the centre of cities the concentration may be up to 0.001 fibres/ml <sup>[ref 11]</sup>.

## 8 Summary

A series of monitoring locations were established around the former TBA site in Rochdale which determined airborne fibre concentrations at monthly intervals over an eighteen month period.

The monitoring network was composed of 4 permanent stations, mainly to the North and East of the site which were selected due to the prevailing wind direction, with additional sites selected for monitoring depending on the wind direction on the survey date. A background site was established 1.7 km south east of the site to ensure the survey was not influenced by materials impacting from further afield.

The monitoring work was conducted in two phases with the initial phase conducted from August 2015 to February 2016, phase 1 was designed to establish the suitability of the monitoring locations and to collect some initial data to inform the monitoring strategy for the main survey (phase 2).

Duplicate samples were taken at each monitoring location according to established monitoring protocols by a consultant from Bureau Veritas's Hazmat team (UKAS 1746). One of each pair of collected filter samples was analysed by Phase Contrast Microscopy (PCOM). The second sample of each pair was archived for analysis by Scanning Electron Microscopy (SEM), if required.

None of the filter samples analysed by PCOM gave a result above the reporting limit of the method (all were <0.01 fibres/ml).

Selected samples from the duplicate sets were analysed by SEM. The decision as to which samples were submitted for analysis was based on the number of fibres observed in the PCOM analysis and the wind direction on the day.

None of the filter samples analysed by SEM in phase 1 of the survey gave a result above the reporting limit of the method (all were <0.001 fibres/ml). One amphibole asbestos fibre was identified by SEM in the sample taken at Harridge Avenue on 16th February 2016, amphibole asbestos includes amosite and crocidolite (brown and blue asbestos). The TBA factory primarily processed chrysotile, also known as white asbestos, this belongs to the serpentine class of minerals, however previous investigations have identified both amosite and crocidolite in areas of the site. The detection limit of the SEM procedure is statistically calculated to be less than the concentration equivalent to three fibres, as discussed in Section 6.2.

The sample obtained from the Broadlea Grove site in June 2016 as part of the phase 2 survey gave a positive result (0.0014 fibres/ml); all of these fibres were identified by SEM as man-made mineral fibre. Man-made mineral fibres were also identified in the samples from Fallowfield Drive taken in February 2017 and Harridge Avenue taken in March 2017. Man-made mineral fibres are typically used for insulation purposes and are not carcinogenic. The Workplace Exposure Limit for man-made mineral fibres is defined in terms of a fibre count (2 fibres/ml as an 8 hour Time Weighted Average exposure) and a gravimetric concentration (5mg/m<sup>3</sup> as an 8 hour Time Weighted Average exposure).

No asbestos fibres were identified in any samples analysed as part of phase 2 of the survey, this included samples taken from the same Harridge Avenue site in June 2016 and March 2017. Twice as many fields were examined by SEM in Phase 2 of the survey compared with phase 1 which increased the sensitivity of the method enabling a reporting limit of <0.0005 fibres/ml to be achieved.

## 9 References

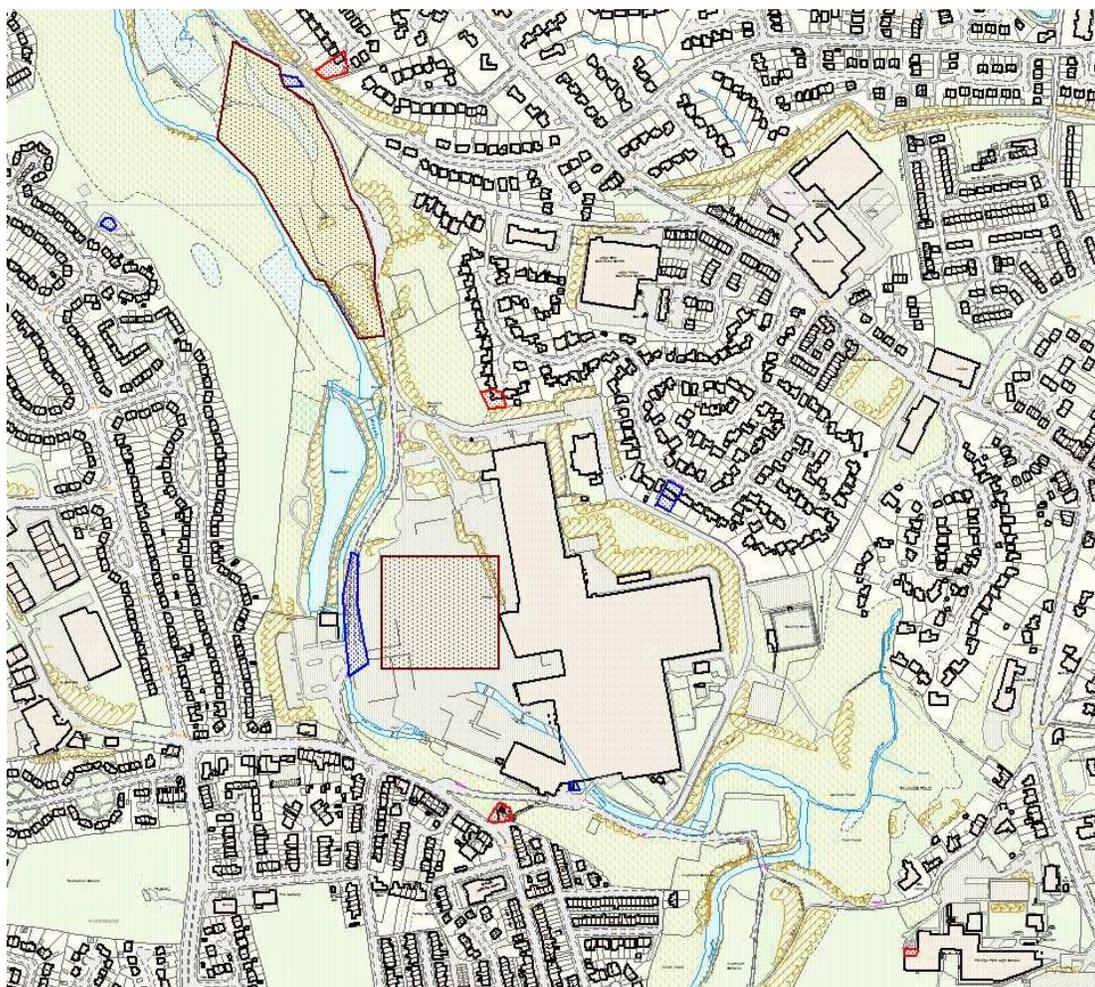
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## Appendix One – Site Map and Photographs



Key

**Red area = Permanent monitoring station**

**Blue area = Variable monitoring location**

**Brown area = Area of known landfilling and unauthorised dumping**



Site location, viewed from the South East



Building range viewed from the North West of the site



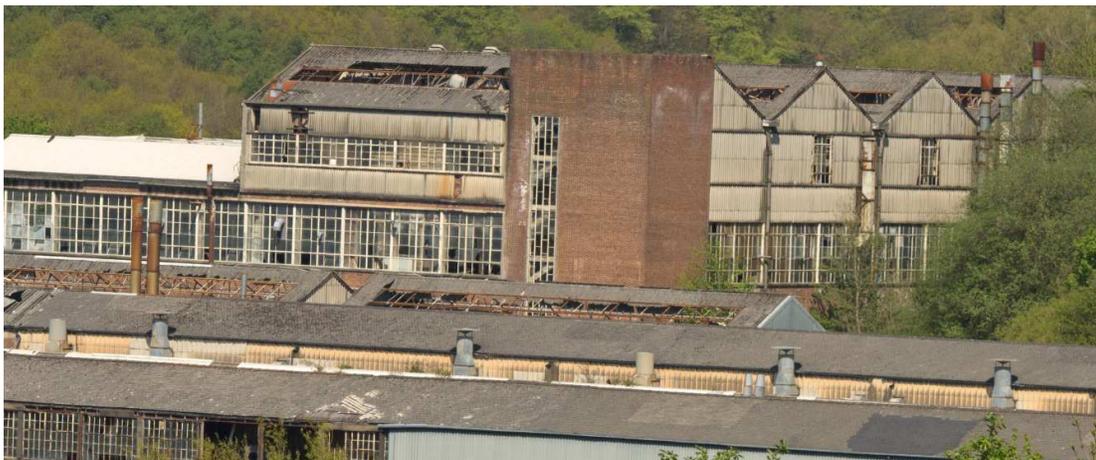
Building range, viewed from the footpath to the West of the site



Damaged roof panels



Building range viewed from the South East of the site



Building range viewed from the South East of the site



Dell & Woodland Road junction



Dell play area



Falinge Park High School



Royds Arms, Rooley Moor Road



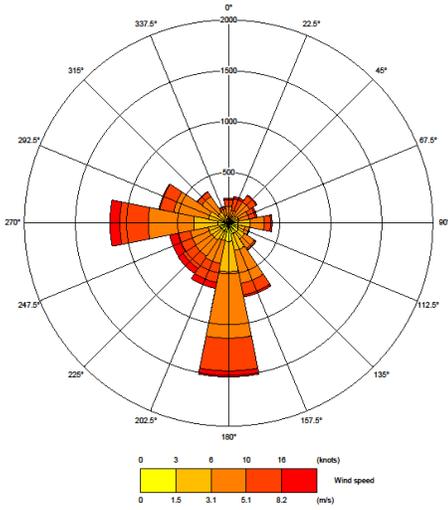
One Riverside, Rochdale



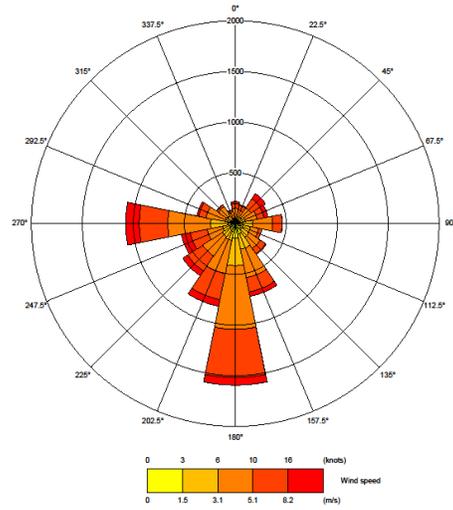
Typical fixed monitoring station



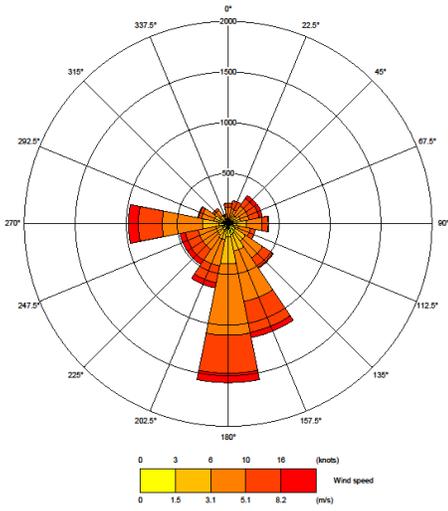
## **Appendix Two – Historic Meteorological Data (Manchester area)**



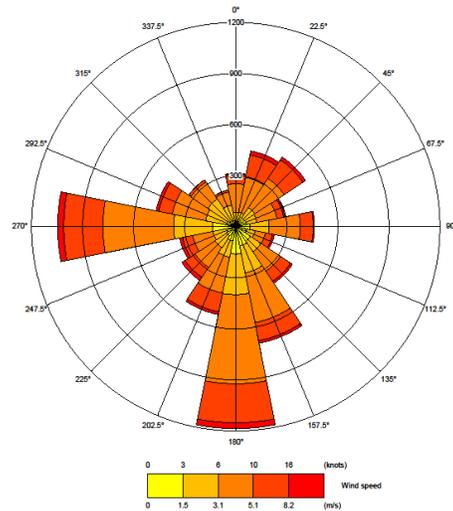
2007



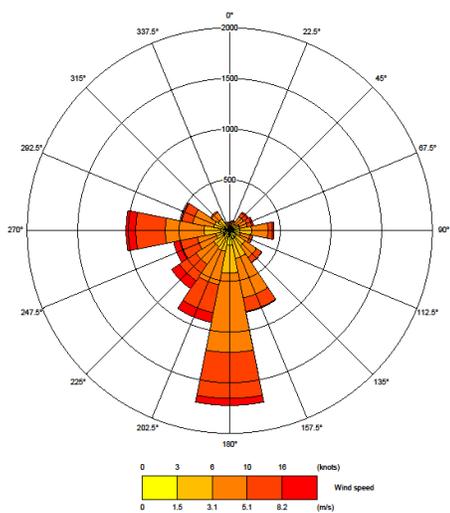
2008



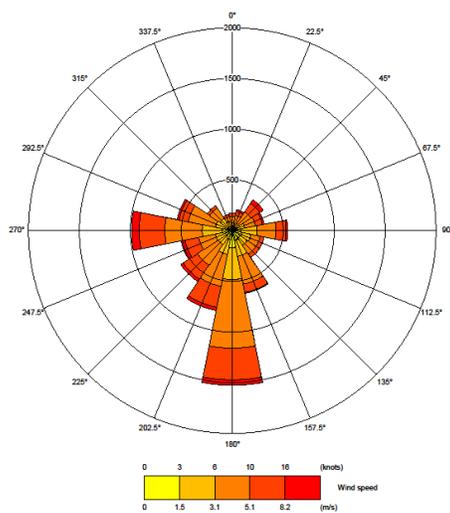
2009



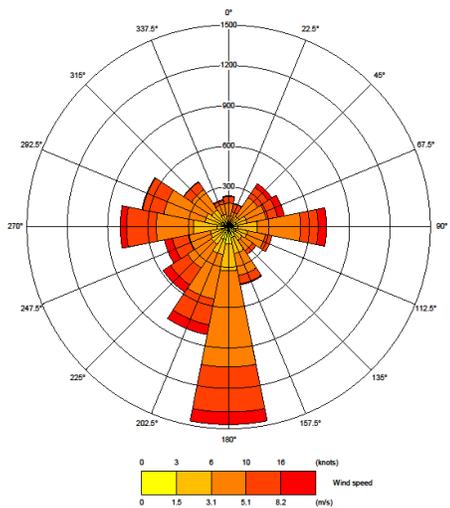
2010



2011



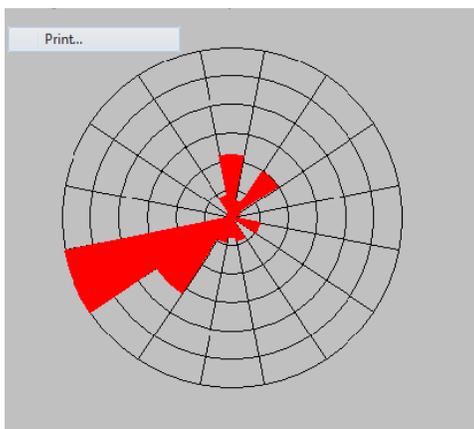
2012



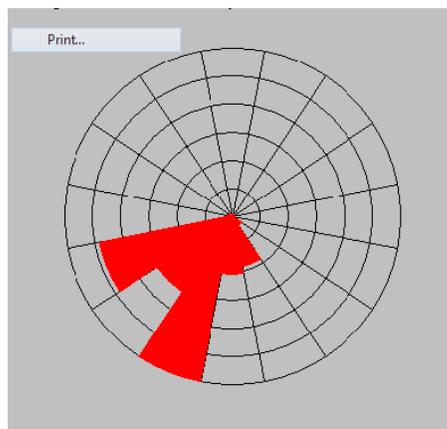
2013



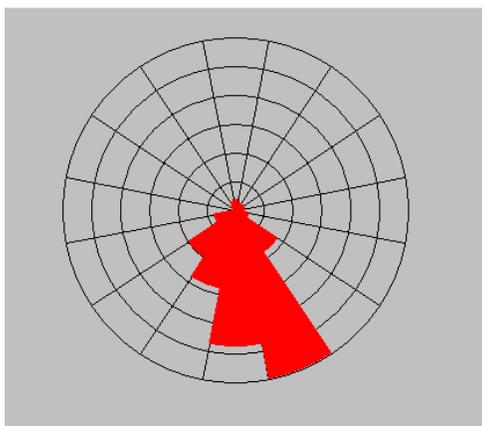
## Appendix Three – Falinge Park School Meteorological Data



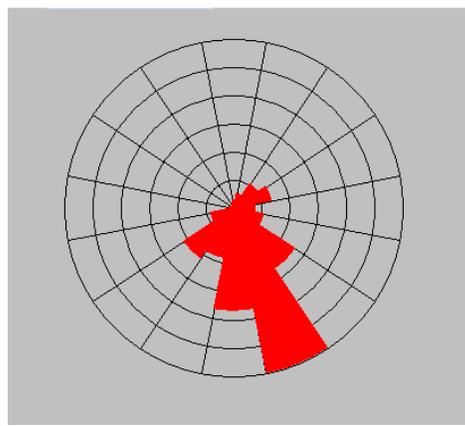
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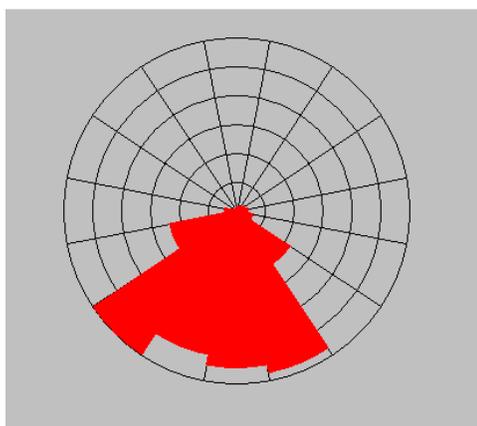
04/11/15 to 25/11/15



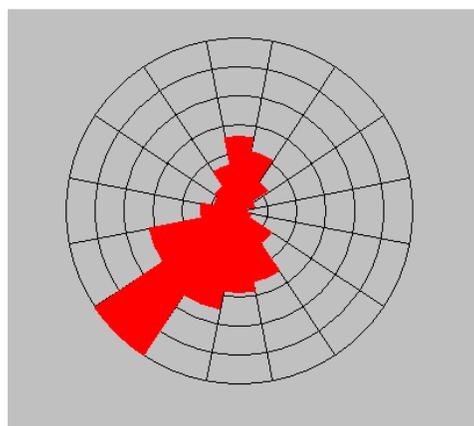
27/11/15 to 17/12/15



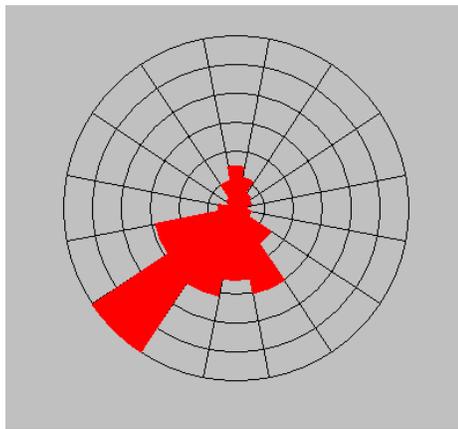
17/12/15 to 13/01/16



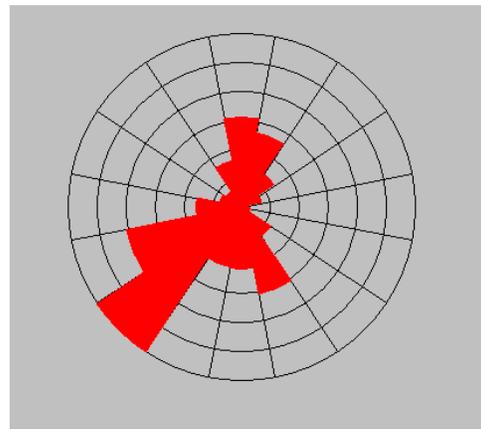
13/01/16 to 10/02/16



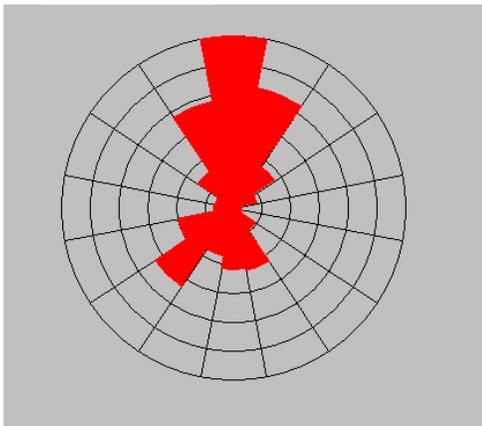
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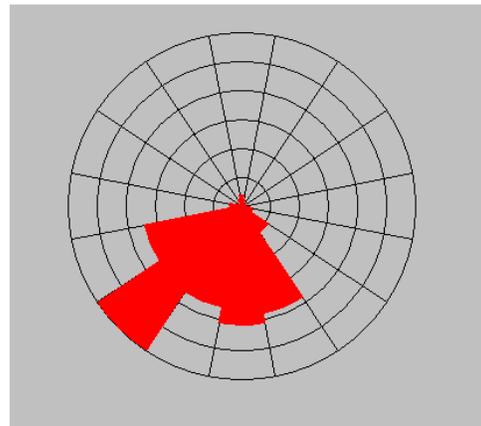
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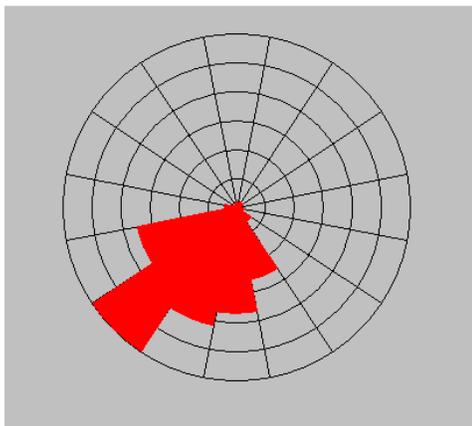
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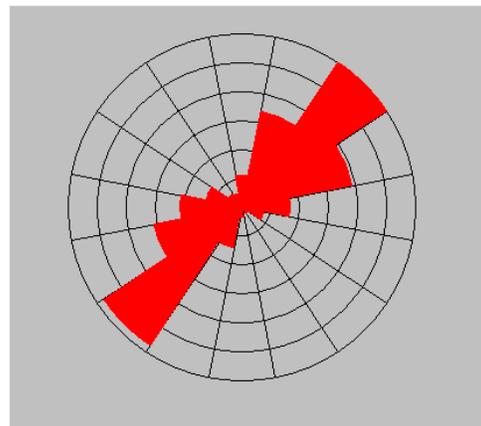
10/05/16 to 15/06/16



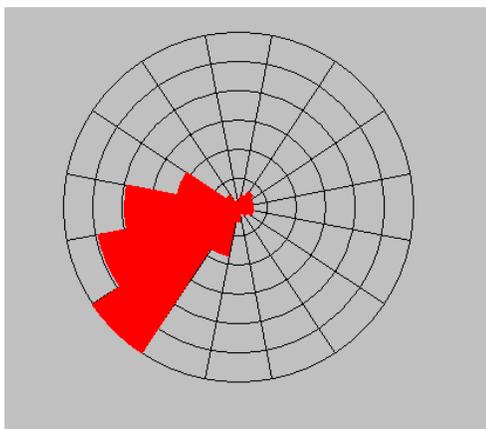
15/06/16 to 14/07/16



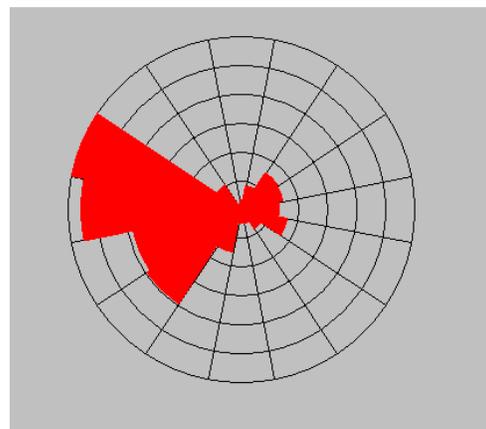
14/07/16 to 16/08/16



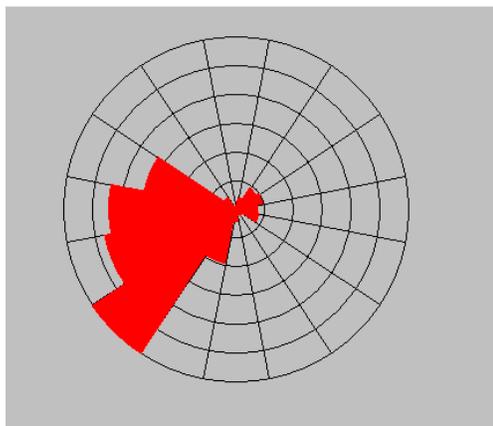
15/11/16 to 30/11/16



30/11/16 to 03/01/17



03/01/17 to 24/02/17



24/02/17 to 28/03/17



## Appendix Four – Monitoring Summary

Phase 1 -. Monitoring results summary (numbers of “fibres” observed in 200 fields), 2015

| Monitoring Date<br>Site address | Aug<br>24/08/15 | Sep<br>16/09/15 | Oct<br>22/10/15 | Dec<br>04/12/15 |
|---------------------------------|-----------------|-----------------|-----------------|-----------------|
| Wind direction (wind from...)   | -               | NNE             | SW              | SSE             |
| Wind speed (m/s)                | -               | 1               | 8               | 7               |
|                                 |                 |                 |                 |                 |
| Harridge Avenue                 | 1               | 1               | 1               | 2               |
| Broadlea Grove                  | 0.5             | 1               | 1               | 2.5             |
| Falinge Park High School        | 1               | 1               | 2 (0)           | 3.5             |
| Royds Arms                      | 0               | 0.5             | 1.5             | 2               |
| 1 Riverside                     | 0.5             | 0               | 1.5             | 1.5             |
| Fallowfield Drive               | -               | -               | -               | 1.5             |

Highlighted results are those selected for SEM analysis, data in parenthesis are fibres counted by SEM

Phase 2 -. Monitoring results summary (numbers of “fibres” observed in 200 fields), 2016

| Date                             | Jan         | Feb        | Mar        | Apr        | May | Jun        | Jul        | Aug | Sep | Oct        | Nov        | Dec         |
|----------------------------------|-------------|------------|------------|------------|-----|------------|------------|-----|-----|------------|------------|-------------|
|                                  | 13/01/2016  | 16/02/2016 | 16/03/2016 | 13/04/2016 | -   | 21/06/2016 | 19/07/2016 | -   | -   | 12/10/2016 | 23/11/2016 | 07/12/2016  |
| Wind direction (FROM)            | S & E / SSW | SSE        | NNE        | S / SW     |     | S          | ESE        |     |     | ENE*       | ENE        | SW          |
| Harridge Avenue                  | 0.5         | 0.5 (1*)   | 0          | 0.5        |     | 1 (0)      | 0          |     |     | 0.5        | 0          | 0           |
| Broadlea Grove                   | 1 (0)       | 0          | 1.5        | 0.5        |     | 1 (9.5**)  | 1          |     |     | 0.5        | 0.5        | 0           |
| Falinge School                   | 0           | 1          | 1          | 0          |     | 0          | 0.5 (0)    |     |     | 0          | 0          | 0           |
| Riverside                        | 0           | 0          | 1          | 0          |     | 0          | 1          |     |     | 0          | 0          | 0           |
| Royds Arms                       | 1           | 1          | 3 (0)      | 0.5        |     | 0          |            |     |     | 0          | 0.5 (0)    | 0           |
| Site security cabin              | 0           |            |            |            |     |            | 0.5 (0)    |     |     |            |            |             |
| Fallowfield Drive                |             | 1          |            | 0          |     | 0.5        | 1          |     |     | 0.5        | 0          | 0.5 (0.5**) |
| Playground                       |             |            | 0          |            |     |            |            |     |     |            |            |             |
| Woodland Road                    |             |            |            |            |     | 0          | 0, 0.5     |     |     | 1.5 (0)    | 0          | 0.5         |
| Woodland Road / Dell Rd Junction |             |            |            |            |     |            |            |     |     |            |            | 0           |

Highlighted results are those selected for SEM analysis, data in parenthesis are fibres counted by SEM (\* amphibole asbestos, \*\*man-made mineral fibres)

Phase 2 - . Monitoring results summary (numbers of “fibres” observed in 200 fields), 2017

| Date                  | Jan | Feb        | Feb        | Mar        |
|-----------------------|-----|------------|------------|------------|
|                       | -   | 01/02/2017 | 21/02/2017 | 15/03/2017 |
| Wind direction (FROM) |     | NE / E     | SW         | SW         |
| Harridge Avenue       |     | 0          |            | 0.5 (1**)  |
| Broadlea Grove        |     | 0          | 0 (0)      | 0          |
| Falinge School        |     | 0          |            | 0          |
| Riverside             |     | 1          |            | 1          |
| Royds Arms            |     | 0.5 (0)    |            | 1.5        |
| Woodland Road         |     | 0.5        | 0 (0)      | 0 (0)      |

Highlighted results are those selected for SEM analysis, data in parenthesis are fibres counted by SEM (\*\* man-made mineral fibres)