



## **London City Airport: Measurement of Volatile Organic Compounds (VOC) Concentrations and Odours**

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July 2010



Experts in air quality  
management & assessment

## Document Control

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# 1 Executive Summary

- 1.1 The 2009 Section 106 Planning Agreement for London City Airport requires that a study be undertaken to measure concentrations of Volatile Organic Compounds (VOCs) and odours in and around the Airport site. This report describes the outcome of this investigation.
- 1.2 London City Airport has received very few complaints related to odours over the past 10 years, despite the expansion of operations that has taken place over this time. The approach that has been taken for this study is innovative, and has been based on measurements of VOCs carried out using a high sensitivity Photo-Ionisation Detector (PID), whilst completing records of perceived “airport odours” during a number of walk-around surveys in the vicinity of the Airport.
- 1.3 An important conclusion of this study is that “airport odours” are not primarily related to aviation kerosene, but are probably associated with organic hydrocarbons produced by the pyrolysis of kerosene in the jet engine, i.e. associated with what are sometimes called ‘burnt’ hydrocarbons. The greatest potential for odour emissions is believed to occur during aircraft taxi movements after landing, when thrust settings are low and the engine components are very hot. By definition, this restricts the frequency of occasions on which “airport odours” will be perceived.
- 1.4 “Airport odours” were perceived within the residential areas to the south of the Airport, but such occurrences were infrequent, and the duration of events was very short. Such observations are consistent with the very low frequency of odour complaints received by London City Airport. Given that “airport odour” events are infrequent and of such short duration (tens of seconds) there are no health concerns for the general public with regard to exposure to airport odours.
- 1.5 Stronger “airport odours” and elevated VOC concentrations were recorded at the Airport Roundabout (close to Connaught Bridge, and adjacent to the Jet Centre). This is the closest point that members of the general public can get to the airport operations; it is an “extreme” location and clearly does not represent conditions within the general community. It was observed that the “jet blast screens” erected at this location provide a very effective means of dispersing aircraft emissions, such that odours and elevated VOC concentrations could not be detected at the downwind side of them. It should also be noted that the peak VOC concentrations recorded at this location were no higher than those recorded on occasions to the north of Royal Albert Dock, when the wind was blowing towards the direction of the Airport (i.e. not associated with Airport sources).
- 1.6 A further important conclusion is that the assessment of potential “airport odour” impacts through modelling of VOC concentrations will be of little benefit, as these odours appear to be unrelated to airport or aircraft-generated total VOC concentrations.

## 2 Introduction

- 2.1 The 2009 Section 106 Planning Agreement for London City Airport requires that a three month study to measure Volatile Organic Compounds (VOC) concentrations<sup>1</sup> and odours in and around the site be undertaken. The specific requirement is as follows:

*Within 12 months of the date of this Deed the Airport Companies shall submit to the Council a report detailing the outcome of studies which shall be undertaken to measure Volatile Organic Compounds concentrations and odours in and around the site. (Third Schedule, Part 3, Item 1 (b)).*

- 2.2 This report is intended to fulfil this obligation. London City Airport has received very few complaints related to odours over the past 10 years, despite the expansion of operations that has taken place over this time. The purpose of this study is to investigate perceived airport odours, where and when they occur, and whether they can be better quantified in the future. It is important to note that there is no evidence from published studies that this type of measurement programme has been previously carried out in the vicinity of an airport. As such, the approach is innovative, and the measurement programme should be regarded as a pilot study.
- 2.3 This report sets out the general background, summarising the various approaches that have previously been used to quantify odours associated with airport operations. It then describes the approach taken for this study, and describes the results that were obtained.
- 2.4 This study has been carried out in association with David Shillito Associates. The field work survey notes completed by David Shillito Associates are provided in Appendix 1 to this report.

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<sup>1</sup> VOC's are organic compounds that are able to evaporate under normal ambient conditions so as to exist as a vapour in the atmosphere. VOC's are numerous and ubiquitous, and are derived from both natural and anthropogenic sources. Levels of VOC's in indoor environments are often higher than in the ambient environment, due to a wide range of VOC-emitting sources in buildings. Some, but not all VOC's are odorous.

### 3 Quantification of Odours at Airports

- 3.1 The assessment of impacts associated with operations that emit odorous compounds is very difficult, even when the source is well defined (e.g. a chimney stack), and the compounds giving rise to the odour are well characterised (e.g. hydrogen sulphide). Where the sources of emission are disaggregated over a wider area, and the emissions are complex in nature (such that a number of components may be contributing to an odour, none of which can be clearly defined) then any assessments become increasingly difficult.
- 3.2 The difficulties are further compounded by the manner in which odours are perceived by the human nose. Such responses are subjective and are dependent upon a number of characteristics including the intensity (the perceived strength of the odour) and the hedonic tone (whether it is pleasant or unpleasant). Odours can be detected at very low concentrations of the chemical compounds giving rise to the odours, sometimes down to several parts per billion (ppb). The human nose is also able to respond to rapidly changing concentrations of odour in the air, such that peak concentrations over durations as short as several seconds can be important.
- 3.3 Various approaches have been taken to study and quantify odours associated with airport operations. These include:
- Odour surveys; and
  - Quantification of total hydrocarbon concentrations
- 3.4 Odour surveys have been carried out at a number of airports, including at Gatwick and Stansted. One of the largest reported surveys was undertaken by Stansted Airport Ltd between August and November 2005<sup>2</sup>, during which period the Airport invited some 14,000 local residents to report any incidents of odour annoyance. During the survey period, only 99 responses were received, the majority of these from residents living a relatively large distance from the Airport. The study concluded that:

*One of the critical aspects of the work has been the low levels of data and information gathered following requests to the local community. There are no persistent reports of odour as there are with noise for example.*

*Without further accurate data and information it is not possible to draw many conclusions about correlations between odour and other factors such as meteorological data because any such correlations would not stand up to statistical challenge and would be supposition. So, although general trends have been found that when prompted, a small number of people living locally will*

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<sup>2</sup> BAA (2006) Generation 1 Environmental Statement Regulation 19 Response Appendix A2 (draft) September.

*indicate that they have experienced an odour occurrence, it has not been possible to deduce any of the causes or factors related to odour occurrences from this study.*

3.5 The assessment work that was carried out for the Stansted Generation 1 Environmental Statement was based on the likely change in the detection of odours associated with the emission of aircraft related VOC emissions. Whilst this has been a commonly-applied approach, there are two principal concerns:

- There is no evidence to correlate total aircraft-related VOC concentrations with the human perception of odours; and
- The modelling studies carried out are based on the prediction of 1-hour average concentrations. Peak concentrations (of less than 30 seconds duration) may be many times higher than the 1-hour mean concentration, but there is no reliable way to calculate these values. As described above, the human nose is able to detect odours over very short time periods.

3.6 As a result of these general concerns, a variation of this modelling approach was undertaken at Copenhagen Airport in 2002<sup>3</sup>. This study quantified odour emissions from aircraft engines using actual fuel flow and emissions measurements, odour panel results, engine specific data and aircraft operational data, and used this information to predict odour concentrations. However, the calculations were carried out for only a limited number of engine types (predominantly the JT8D-219) and the study recognised that “*the uncertainties become large when the experimental data is used to estimate the odour emissions for all aircraft engines*”. Furthermore, the aircraft engine odour data were not published, and have not subsequently been applied in other assessments. However, one particularly interesting conclusion of the study was that “*most of the odour emissions come from the taxi phase after landing*”. A further conclusion was that the study calculated an odour emission rate from the aircraft engines of 57 Odour Units<sup>4</sup> per milligram of hydrocarbon. This can be readily converted into a more conventional odour threshold value of 2.9 parts per billion (ppb). Such a value is not typical of the odour threshold for aviation fuel, which is in the region of 1-10 parts per million (ppm) (i.e. about 1000 times higher). This suggests that the odour emission rate calculated in this study was not associated with kerosene vapour, but with other organic compounds with much lower odour thresholds. These aspects are discussed in later sections of this report.

<sup>3</sup> Winther M, Kousgaard U and Oxbol A (2006) Calculation of odour emissions from aircraft engines at Copenhagen Airport, *Sci Tot Env*, 366, 218-232.

<sup>4</sup> In simple terms, olfactometry is the technique used to measure the concentration of an odour by taking samples of odorous air and then evaluating the number of dilutions at which the sample is only detected by 50% of the odour panel. The number of dilutions required to achieve this odour threshold is expressed as odour units per cubic metre.

## History of Odour Complaints at London City Airport

- 3.7 London City Airport operates an environmental complaint handling procedure by which anyone can contact the Airport to register a complaint or request information about Airport operations. Complaints or requests for information can be registered by telephone, post, email or via the Airport website. Each complaint or request for information is registered by the Airport, and then investigated and resolved where appropriate and practical. All environmental complaints and enquiries made to the Airport are reported to the London Borough of Newham and a summary provided to the London City Airport Consultative Committee.
- 3.8 A summary of the environmental complaints related to air quality issues since April 2000 is shown in Table 1. This confirms that there have only been 9 complaints associated with airport odours over the past 10 years, despite the expansion of the Airport over this period.

**Table 1: Summary of Air Quality Complaints**

Year	No. Complaints	Nature of Complaint
2000	2	Airport odours
2001	2	Airport odours
2002	1	Smoke
2003	0	
2004	0	
2005	2	Airport odours
2006	1	Airport odours
2007	1	Airport odours
2008	0	
2009	1	Airport odours

## Objectives of this Study

- 3.9 The principal objective of this study was to investigate whether any relationship could be found between measured atmospheric VOC concentrations and perceived “airport-related” odours in the vicinity of London City Airport. There are no published data to suggest that such studies have been undertaken before. The study also investigated whether any specific airport activities could be associated with “airport-related” odours, and the extent and frequency of perceived odours in the general environment.

## 4 Approach

- 4.1 The atmosphere contains a mixture of organic compounds. The major component is methane (CH<sub>4</sub>) which has no detectable smell. The range of other more minor “non-methane” compounds is large and variable; in total, they typically represent a concentration which is about 10 times lower than methane. In classic monitoring methods, air samples are taken in special bags or adsorption tubes, and are then taken to a laboratory where the components of the sample are separated and analysed by gas chromatography or GCMS. This type of monitoring is suited for monitoring VOC concentrations over periods of several hours to several days. However, this is far from ideal for shorter time periods, where peak concentrations measured over a number of minutes or even seconds are important.
- 4.2 During the 1990s, the technique of photo-ionisation detection was developed, using high intensity photons in the UV range, to break molecules into positively charged ions, rather than by ionisation in a hydrogen flame. The “broad band” photo ionisation detector ionizes all the hydrocarbons with an ionization energy less than or equal to the lamp output, but is most sensitive for gases which have ionization energies similar to the photons that the detector uses. This selectivity is used to “tune” the instrument to the components of interest.
- 4.3 These developments led to the design of a new generation of hand held photo ionisation detector (PID) instruments, which do not suffer interference from methane and which are capable of recording real-time concentration data, with very low detection limits and extremely short response times of a few seconds. These new instruments are ideal for use in “walk-round surveys”, to identify and measure possible sources of VOC emissions, and to map the extent of exposure around potential sources. These new high sensitivity PIDs have become particularly important in environmental work in odour assessment, and provide the only means currently available for measuring peak concentrations of a range of hydrocarbon compounds over a periods as short as a minute.
- 4.4 This pilot study proposed the use of high sensitivity PID’s to measure the VOC concentrations around London City Airport to examine the contribution made by aircraft and road traffic emissions, against the influence of the local background levels.
- 4.5 It was intended that a series of “walk round” surveys would be undertaken over a three month period, ideally during different wind directions. Days with different wind direction were selected in order to assess exposures to the north, west and south of the Airport operational areas at the west end of the Airport, concentrating on areas where members of the public might be present. As odour concentrations tend to be inversely proportional to wind strength, the surveys were carried out on days with lighter winds wherever possible.

- 4.6 The study was carried out during the late spring to mid-summer period, as VOC emissions associated with evaporative sources would be expected to be higher at this time.
- 4.7 As stated previously, it is important to note that this was intended to be a pilot study that was designed to exploit innovative approaches and new instrumentation not previously used in the vicinity of airports.

### Survey Periods and Instrumentation

- 4.8 In total, six survey periods were carried out on 13-14<sup>th</sup> April, 25<sup>th</sup> May, 9-10<sup>th</sup> June and 30<sup>th</sup> June 2010. The early part of 2010 was characterised by cold, often rainy weather, and as set out above it was considered important that the study should focus on periods of warmer weather. The onset of the study was therefore necessarily delayed until mid-April. In addition, whilst further surveys were planned for the 15<sup>th</sup> April onwards (when the weather conditions were “ideal”, with light, northerly winds) the Airport was unexpectedly closed for a period of a week due to the volcanic ash problems.
- 4.9 The identity of those compound(s) responsible for the characteristic “airport odour” have not been established from any studies yet reported in the scientific literature, and it is not known if they are simple hydrocarbons or more complex derivatives. The PID instruments used for this survey cannot distinguish between the various VOC compounds, and cannot specifically identify the compounds that give rise to an odour, but this was not the primary objective of this investigation.
- 4.10 For the first two periods of the study (13<sup>th</sup> and 14<sup>th</sup> April 2010), a RAE Systems PID instrument, a “MiniRAE 3000”, with a detection limit of 0.1 ppm (100 ppb), was hired from Ashtead Technology.
- 4.11 A more sensitive instrument, a “ppb RAE Original” instrument, was later sourced by Ashtead Technology from the USA. This instrument has a much lower detection limit of 0.001 ppm (1 ppb). It was first deployed in a survey carried out on 25<sup>th</sup> May 2010, but it was considered that the instrument was not functioning reliably, and it was returned to the supplier for servicing. This instrument was later used in the surveys on 9<sup>th</sup> and 10<sup>th</sup> June, but the background VOC levels recorded (which were constantly in the range 1.5 – 2.5 ppm) were not considered credible. Subsequent discussions with the instrument manufacturer, RAE Systems, confirmed that the VOC concentrations recorded by this “ppb RAE Original” instrument could not have been correct and the data were necessarily discarded, and are not included in this report.
- 4.12 Finally, a high sensitivity “RAE 3000” PID was loaned from RAE Systems UK. This instrument is considered to be the best and most up-to-date technology of this type that is currently available anywhere in the world. It has a low detection limit of 0.001 ppm (1 ppb), a redesigned sensor head, and is temperature and humidity corrected. Facilities were also provided to zero-calibrate the instrument on site to counter problems of drift, which is critical for an instrument of such high sensitivity.

- 4.13 All of the PID instruments were pre-calibrated with iso-butylene, with a correction factor of 0.67, i.e. when exposed to 6.7 ppm of aviation kerosene (JP-8) vapour, the instrument reading would be 10 ppm.
- 4.14 Meteorological data were also recorded during the surveys using a Kestrel 2500 instrument, indicating wind speed, maximum gust and average speed.
- 4.15 A description of the field surveys carried out on 13<sup>th</sup> – 14<sup>th</sup> April, and 30<sup>th</sup> June 2010, together with the field survey records completed by David Shillito Associates, are provided in Appendix 1. As set out above, the VOC concentrations recorded on the other three survey days were discarded.

## 5 Results and Discussion

5.1 VOC concentrations measured on 13<sup>th</sup> and 14<sup>th</sup> April were often at, or below the detection limit of the PID instrument (0.1 ppm, or 100 ppb), and it was concluded that the instrument did not provide sufficient sensitivity to fully investigate the potential links between VOC concentrations and perceived “airport odour”. However, these walkover surveys did provide two very important findings:

- The Airport operations did not make a major contribution to VOC concentrations in the general area; and
- The odour threshold of the “airport odour” was very low, and below the detection limit of the instrument.

5.2 The surveys carried out on 25<sup>th</sup> May and the 9<sup>th</sup> - 10<sup>th</sup> June confirmed the extent and duration of recognisable “airport odours”, but as described earlier, the measured VOC concentrations were thought to be unreliable and have not been reported.

5.3 The survey carried out on 30<sup>th</sup> June allowed much more reliable VOC concentrations to be mapped. Background VOC concentrations at locations away from roadsides were generally very low, and often close to the detection limit of the instrument (0.001 ppm, or 1 ppb). Typical VOC concentrations close to roads were of the order of 20-30 ppb. Important findings were:

- “Airport odour” could be recognised, lasting for short durations of between 10 and 60 seconds. During such events, VOC concentrations were approximately 20 ppb higher;
- Very high VOC concentrations (above 2.4 ppm or 2,400 ppb) were recorded to the north of Royal Albert Dock, and were believed to be associated with a plume of an “odour masking agent” used by the Williams waste transfer site<sup>5</sup>, located at Charles Street (some 800 metres away from the sampling point at the Newham Dockside building);
- VOC concentrations measured within buildings (e.g. the Newham Dockside building) were elevated above the general background, with levels approaching 0.05 to 0.10 ppm (50 to 100 ppb).

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<sup>5</sup> Odour masking agents or “deodorisers” are frequently used by waste transfer stations to control odours. They are usually sprayed across the working areas.

## General Conclusions

- 5.4 A number of broad conclusions can be drawn from the Pilot Study work. These are set out below.

### *Relationship Between VOC Concentrations and Odours*

- 5.5 The relationship between VOC concentrations and “airport odour” was first assessed from the vicinity of the Long Stay car park. Observations were made of aircraft landing on an easterly runway allocation (due to the north east wind), coming to a halt, turning, and then taxiing back to the Terminal. At a location approximately 300 metres from the aircraft turning point, aircraft odours could be detected for brief periods of about 30 seconds. During such periods, no elevated VOC concentrations were recorded on the Mini RAE 3000 PID instrument (i.e. VOC levels were less than 0.1 ppm or 100 ppb).
- 5.6 The later survey (30<sup>th</sup> June) carried out with the “high sensitivity” RAE 3000 (with a detection limit 100 times lower) identified VOC concentrations of less than 20 ppb above the background during periods when “airport odour” was detected. As the contribution of other VOCs cannot be dismissed, this suggests that the odour threshold of “airport smell” is below 20 ppb. As the odour threshold of aviation kerosene is in the range of 1 to 10 ppm (1000 to 10,000 ppb), kerosene cannot directly be the cause of the perceived “airport odour”.
- 5.7 It is concluded that “airport odours” are not normally related to concentrations of aviation kerosene vapour or to VOC concentrations in general, but are probably associated with organic compounds produced by the pyrolysis of jet fuel in the hot engines. The most likely group of compounds are aldehydes, the simplest being acrolein (or acraldehyde). These aldehydes have very low sensitivity in PID instruments, but are known to be produced when kerosene fuel comes into contact with hot metal. Acrolein has a very low odour threshold ( $0.038 \mu\text{g}/\text{m}^3$  or 0.02 ppb)<sup>6</sup>.
- 5.8 This general conclusion is supported from the work of Winther *et al* (2006) (see Section 2 of this report), who found that “most of the odour is associated with aircraft taxi after landing”. This would relate to hot engines operating with low thrust settings. It further corresponds with the low odour threshold calculated for the aircraft emission in the Copenhagen study, which is not representative of aviation fuel.

### Short-term VOC Concentrations

- 5.9 In the ambient environment, vehicular traffic on the roads was responsible for non-methane VOC concentrations of around 20 - 30 ppb, with higher concentrations found with higher traffic densities. These levels are relatively low in comparison to the non-methane VOC concentrations that can be

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<sup>6</sup> Woodfield and Hall (1994) Odour Measurement and Control – an update. Prepared by AEA Technology of behalf of the Department of the Environment.

found inside buildings, most likely arising from furnishings, food, copying and printing facilities etc. Typical levels of non-methane VOCs can rise to 50 to 100 ppb in buildings.

- 5.10 Overall the variation in short-term peak hydrocarbon concentrations found in the area of London City Airport is not wide. The survey suggests that the contribution made by the Airport is no greater than that from the local roads. Much higher VOC contributions from the Airport were identified at the eastern pavement of the Airport Roundabout. This is the closest point that members of the general public can get to Airport activities, and the distance between the aircraft and the pavement is only about 50 metres. During periods when aircraft on the Jet Centre apron were being prepared for departure, with engines running, strong “airport odours” were recorded, with VOC concentrations rising to 4 ppm above background. It should be noted this point represents an “extreme location” and is not representative of general public exposure in the vicinity of the Airport. It should also be noted that odours and elevated VOC concentrations were not recorded behind the “jet blast” screens, and it is concluded that these screens strongly enhance the dispersion of the emissions, providing a very effective means of preventing “airport odours”. It should further be noted that the peak VOC concentrations recorded at this location were no higher than those recorded on occasions to the north of Royal Albert Dock, when the wind was blowing towards the direction of the Airport (i.e. not associated with Airport sources).

### Observations of Odours in the General Community

- 5.11 A constant record of any perceived “airport odours” was maintained throughout the walk-around surveys. Whilst “airport odours” were recorded, they were infrequent and usually of very short duration (several seconds to tens of seconds). These observations are consistent with the low level of odour complaints that have been received by the Airport over the past 10 years (as set out in Section 2 of this report).
- 5.12 Over flat, open areas (e.g. over open expanses of water across the Dock) odours could be detected over distances of approximately 300 - 350 metres. These incidents coincided with aircraft landing during north easterly winds, and specifically with aircraft turning at the end of the runway to taxi back to the Terminal. By definition, such occurrences were infrequent and of short duration (less than 60 seconds).
- 5.13 Within the residential area to the south of the Airport, “airport odours” were restricted to the area to the north of Albert Road, and for the majority of the time to the north of Drew Road. Such incidents were infrequent and of very short duration. A specific observation was that the buildings and structures that lie between the Airport and residential dwellings to the south appears to enhance the dispersion of the VOCs from Airport operations (as odours were more noticeable when transported over the open waters of the Dock).

## 6 Conclusions

- 6.1 A principal conclusion of this Pilot Study is that “airport odours” are not primarily related to aviation kerosene, but are probably associated with organic hydrocarbons produced by the pyrolysis of kerosene in the jet engine, i.e. associated with what are sometimes called ‘burnt’ hydrocarbons. The greatest potential for odour emissions is believed to occur during aircraft taxi movements after landing, when thrust settings are low and the engine components are very hot. By definition, this restricts the frequency of occasions on which odours would be detected.
- 6.2 The most likely group of compounds to be associated with “airport odours” are the aldehydes. They are known to be formed as pyrolysis products when aviation kerosene comes into contact with hot metal surfaces, and they are characterised by very low odour thresholds. Aldehydes can only be detected with very low sensitivity by even the most sensitive PID instruments available on the market.
- 6.3 It is not known with certainty whether aldehydes are responsible for the perceived “airport odour”, and if they are, which specific compounds are involved. However, it is a plausible conjecture that acrolein may be involved. Acrolein (or acraldehyde) is one of the simplest aldehydes and has a reported odour threshold of 0.02 ppb. This would suggest that the odour would be strong enough to be recognisable at levels above about 0.2 ppb. The reported Short Term Exposure Limit (STEL)<sup>7</sup> for acrolein<sup>8</sup> is 0.3 ppm (300 ppb), i.e. 1500 times higher than the concentration at which it is likely to be recognisable. Given that “airport odour” events are infrequent and of very short duration (tens of seconds) there are no health concerns for the general public with regard to exposure to airport odours.
- 6.4 “Airport odours” were detected within the residential areas to the south of the Airport, but such occurrences were infrequent, and the duration of events was very short. Such observations are consistent with the very low level of odour complaints received by London City Airport.
- 6.5 A further important conclusion is that the assessment of potential odour impacts through modelling of VOC concentrations will be of little benefit, as airport odours appear to be unrelated to airport or aircraft-generated total VOC concentrations.

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<sup>7</sup> The STEL refers to exposure over a 15 minute period

<sup>8</sup> EH40/2005 Workplace exposure limits. [www.hse.gov.uk/coshh/table1.pdf](http://www.hse.gov.uk/coshh/table1.pdf)

## A1 Appendix 1: Field Surveys undertaken by David Shillito Associates

### Survey Route

- A1.1 The general survey route started from the Long Stay car park to the Terminal, and then either along Hartmann Road or through the residential areas to the south. It then continued to the Hartmann Road traffic lights, the gates to the Jet Centre, and to the Airport Roundabout at the south end of Connaught Bridge. From this location the route continued northwards on the public footpath, behind the jet blast screens at the Jet Centre, to the south west end of the Royal Albert Dock, over the footbridge to the northern side of the dock and eastwards to the Regatta Centre. The route was then retraced back to the Terminal and Short Stay car park. Occasional observations were also made inside buildings, including Newham Dockside for comparative purposes.
- A1.2 The general survey route is indicated in Figure A1 below. A wider-scale map (Figure A2) shows the locations of other nearby sources of VOC/odour emissions.
- A1.3 Throughout the survey, Airport Kerosene Odour has been recorded as “AKO”.

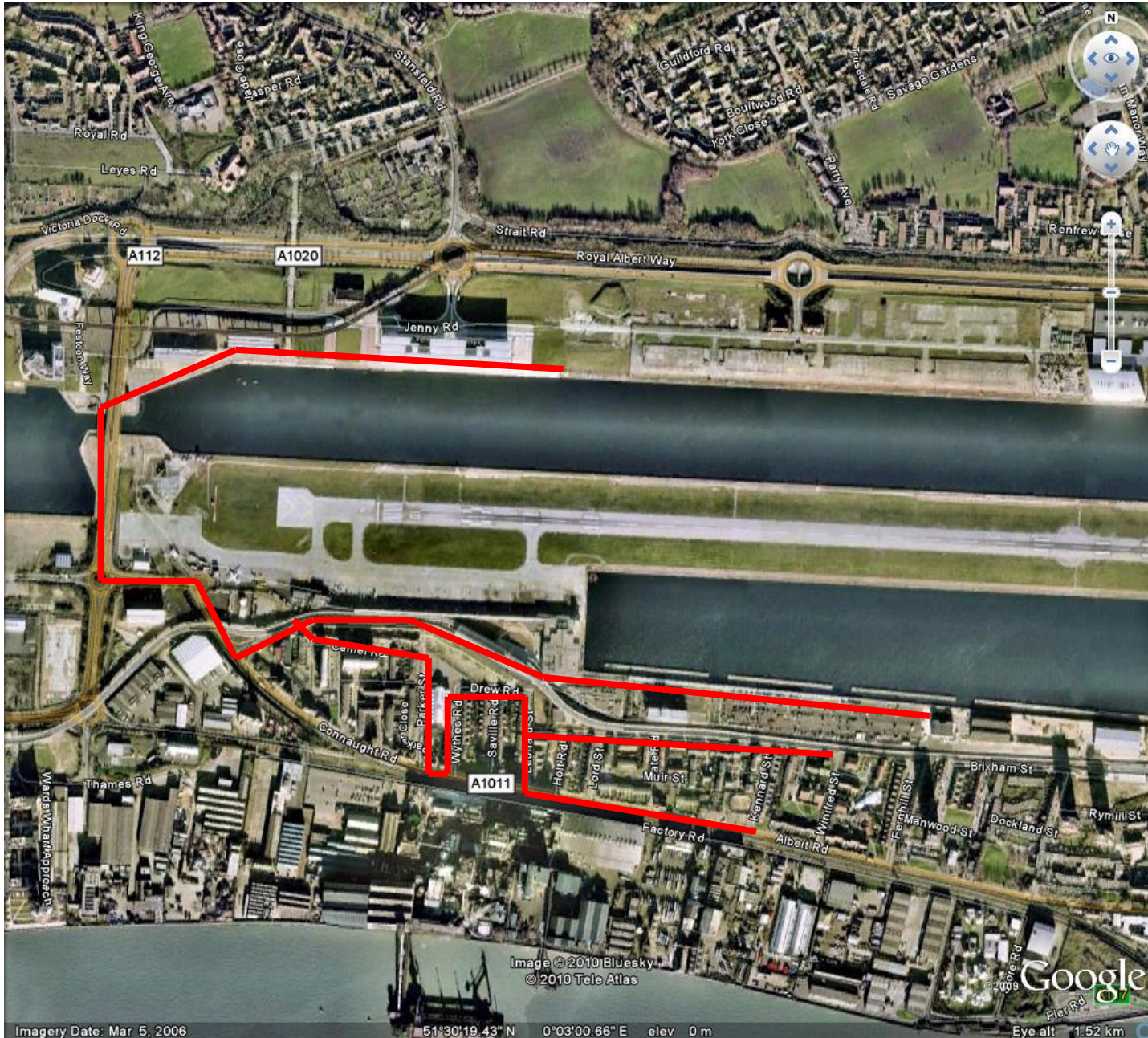
### 13<sup>th</sup> and 14<sup>th</sup> April 2010

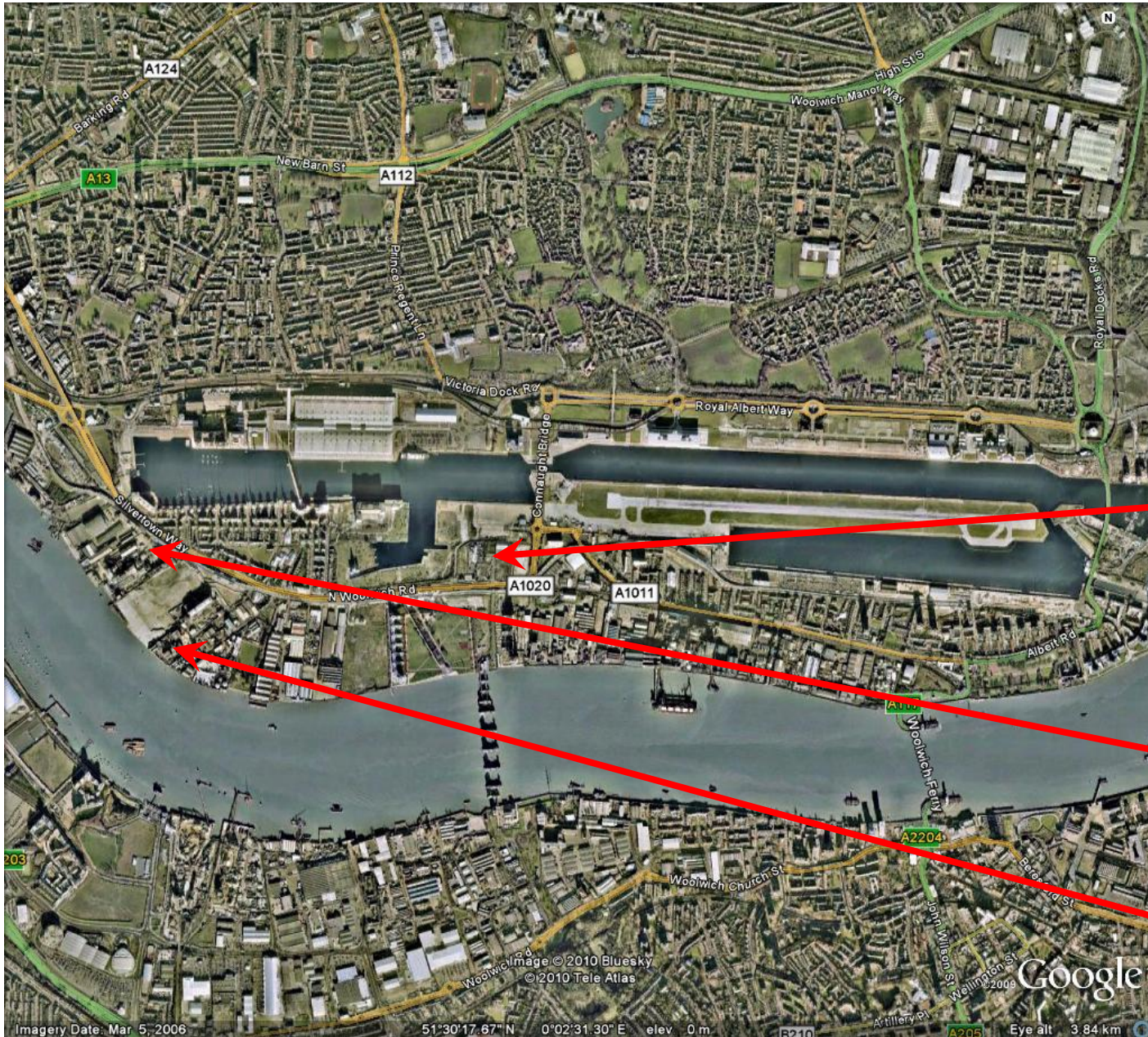
- A1.4 The first group of surveys was carried out in mid-April, taking advantage of the forecast period of stable, north easterly winds. Such a wind direction will carry emissions from Airport operations to the closest residential housing, to the south of Hartmann Road.
- A1.5 On the afternoon of Tuesday 13<sup>th</sup> April, and all day on Wednesday 14<sup>th</sup> April, five “walk round” traverses were made in the areas to the south of the Airport, at locations where the public have access to the perimeter. VOC concentrations were measured continuously and a record made of any “airport smell”.

### 30<sup>th</sup> June 2010

- A1.6 Meteorological conditions on 30<sup>th</sup> June were south westerly to southerly winds, which would tend to carry airport emissions to the north of the Royal Albert Dock. A full “walkover” survey was completed in the morning and supplemented by a drive around survey in the afternoon.

Figure A1: Odour Survey Route, indicated by red lines





**Figure A2: Location of other VOC/odour sources in the area**

Williams Waste Transfer Site

Akzo Nobel Resins

John Knights (Renderers)

## Chronological Observations & Results (Field Notes)

### Tuesday 13<sup>th</sup> April 2010

Arrived at airport at 1315 hours, went to Terminal to check that flight operations were as normal. Went to location at the side of King George V dock, near end of Long-stay car park).

Equipped with RAE Systems MINI RAE 3000 PID

- At 1330, with the wind speed gusting from 5 m/s to 9 m/s, from the N.E. Wind direction and gust condition could be judged by the movements of the surface waters. Temperature 16°C.
- Aircraft were landing and taking off west to east.
- Arriving aircraft were coming to a stop at the completion of their landing and were turning round 180° to taxi back to the Terminal area.
- The monitoring location could be adjusted to stay directly downwind of the turn-round position to allow measurement of greatest VOC concentrations in those wind conditions.
- Several types of airliner observed including RJ 80, Embraer 190, Dornier 328 Fokker 50.
- In wind speeds of 5 m/s to 9 m/s faint kerosene odours were observed from jets with no movement from “0.0” (zero concentration) on PID.

Time	Location/Observations	Odours	PID ppm
1500 hrs	Returned to King George V Dock to check wind conditions much the same as before. Only observable change was a decrease in frequency of stronger wind gusts. Slight AKO smells were observed originating from some aircraft mainly the larger jets as RJs and Embraer. No response was found to PID instruments.	Slight AKO	0.0
1600 hrs	At King George V Dock NE Wind speed significantly reduced: 3 m/s, peak gust 5m/s.		
1615 hrs	Falcon landed and turned on runway, smells of AKO noted but no deflection from “0” on PID. Assume concentrations of non-methane HC was less than 0.1 ppm. (Noted that wind direction still gave exposure)	Slight AKO	0.0
1625 hrs	RJ 80 landing with wind giving peak gust of 7 m/s.	None	0.0
1630 hrs	Started traverse of Airport: Terminal Set-down point, crossed over to Hartman Road pavement, down hill, passed junction with Camel Road, to traffic lights at junction with Connaught Road. Remained on NE side of Connaught Road (caution to road works) to Jet Centre roundabout.	Occasional, faint AKO	0.0
1700 hrs	On road side (W) of brick wall	Strong AKO	0.3-0.4 ppm
1715 hrs	Arrived Airport Roundabout at Connaught Bridge, at the gap between the jet blast screen walls and the building which provides a view of the Jet centre apron and the west end of the airport. This point provides a popular viewing point for plane spotters and other interested parties. Wind speed 4 m/s.	AKO	Up to 0.5 ppm
1725 hrs	RJ landed: no response at Airport Roundabout	None	0.0

1728 hrs	Small Ex Jet landed: No response at Airport Roundabout.	None	0.0
1737 hrs	Small Ex jet moving on Apron of Jet Centre. When jet shut down engines concentrations dropped down 0.2 to 0.1 ppm over about 2 minutes.	AKO	Up to 1.1 ppm
1744 hrs	RJ landed: no response at Airport Roundabout	None	0.0
1745 hrs	Observed an Ex et being fuelled no odour noticed and no detection on PID although down wind.	None	0.0
1805 hrs	Left Airport Roundabout on Connaught Bridge walking back to Jet Centre Gate.	None	0.1 ppm
1810 – 1814 hrs	Walked Connaught Road/ Hartmann Road.	Occasional and faint AKO	0.1 ppm
1815 hrs	At Camel Road/Hartmann Road intersection.	None	Up to 0.5 ppm
1820 hrs	Footpath from down from Hartmann Road to end of Parker Street.	None	0.1 ppm
1825 hrs	Parker Street / Drew Road.	None	0.0
1830 hrs	Newland Street / Holt Road	None	<0.1 ppm
1840 hrs	Return through Terminal set down/pickup point to short stay car park and City Aviation House.	None	0.1 ppm
1903 hrs	Return to Long Stay car park (East end) with no aircraft movements and no action upwind. Re booted PID but still gave a reading of 0.1 ppm Wind gusting to 8 m/s temperatures had fallen to 11.6 0 C still NE direction.	None	0.1 ppm
1915 hrs	Odours at East end of Short Stay car park. PID showing concentrations of 0.1 ppm.	AKO	0.1 ppm
1930 – 1935 hrs	Around short stay car park. Finish at 1935 hrs.	Occasional faint AKO	0.1 ppm

**Wednesday 14th April 2010**

Arrived at airport at 0740 hours:

Conditions: Pressure 1020 mb, Wind NE 10 mph, 80C Dew point 30C, overcast with cloud base at 3,000 ft.

Time	Location/Observations	Odours	PID ppm
07.50 – 0803 hrs	At side of King George V dock, near mid point of Long-stay car park. PID 0.1ppm faint AKO smells from aircraft as they completed their landings and turned to taxi back to the terminal. Wind NE average 3.6m/s max gust 4.9 m/s Temp 8.3 deg C.	Faint AKO	0.1 ppm
0807 hrs	RJ 80 landing.	Faint AKO	0.0
0810 hrs	Wind 3.5 m/s	Faint AKO	0.0
0820 hrs	Short Stay car park faint AKO PID = 0.1ppm	Faint AKO	0.1 ppm
0822 hrs	Flags area outside Terminal (east side)	None	0.0
0827 hrs	Steps down from Pickup area to Newland Street	None	0.0
0834 hrs	Parker Street / Camel Road	Very faint AKO	0.0
0840 hrs	Hartmann Road traffic lights	Faint AKO	0.1 ppm
0845 hrs	Back eastwards on Camel Road	Faint AKO	0.1 ppm
0855 hrs	Drew Road to Connaught Rd	Faint AKO	0.1 ppm
0857 hrs	Jet Centre Gate Security	None	0.1 ppm
0900 hrs	Airport Roundabout	AKO	<0.2 ppm
0906 hrs	Airport Roundabout with ex jet manoeuvring on apron.	Strong AKO for very short durations	0.3 – 0.7 ppm, peaking at 4 ppm
0920 hrs	Continued down footpath behind the jet blast screens to west end edge of the Royal Albert Dock by swing bridge assembly. Noted that the wind appear to have veered to ENE/E. Progressed over footbridge to North side of Royal Albert Dock. In front of the YI BAN restaurant and boat house. Noted that the PID was now reading 0.1ppm persistently. Temperature still 8 deg C.	None	0.0 ppm
1004 hrs	Hartmann Road Road/ Connaught Road.	None	0.2 ppm
1007 hrs	Hartmann Road Camel Road.	Faint AKO	0.1 ppm
1020 hrs	Inside Terminal Building PID = 0.2 ppm	None	0.2 ppm
1030 hrs	Short Stay car park	AKO	0.1 ppm
1130hrs	Restart PID	None	0.0
1145 hrs	Holt Road / Newland Road	None	0.0
1155 hrs	Camel Road / Hartmann Road	None	0.1 ppm
1200 hrs	Hartmann Road/ Connaught traffic lights	None	0.1 ppm
1205 hrs	Airport Roundabout, Connaught Bridge	None	0.0
1225 hrs	South side of west end of Royal Albert Dock: Wind check max gust 4.9m/s average 2.7 m/s Temperature 9.3 degC	None	0.0
1227 hrs	On the footpath Immediately behind jet blast screens.	None	<0.1 ppm
1231 hrs	Airport Roundabout: arrival of a small Ex jet. PID level dropped down to 0.1ppm after engines had been switched off. Continued back to Terminal	Faint AKO	0.4 ppm

1240 hrs	On Connaught Road, traffic under DLR bridge produced a flip in PID response from 0.1 ppm to 0.2 ppm, peak surges lasted for 15 seconds or so.	None	<0.2 ppm
1245 hrs	Hartmann Road traffic lights.	Faint AKO	0.1 ppm
1255 hrs	Outside Terminal Building. Outside International Arrivals PID = 0.2 ppm, possibly from food area Upstairs PID = 0.1 ppm Downstairs PID = 0.1 ppm	None	0.1 ppm
1300 hrs	Closed down		
1450 hrs	Restart at King George Dock: Wind ENE U = 4m/s Uav = 3 m/s Temperature 9 degC	None	0.0
1500 hrs	Flags area (East of Terminal)	None	<0.1 ppm
1502 hrs	Top of steps down to Newland Road.	None	0.1 ppm
1505 hrs	Leonard Street: no smells	None	0.0
1507 hrs	Saville Road / Drew Road	Faint AKO	0.1 ppm
1509 hrs	Wythes Street, continuing In front of New Drew Road School	None	0.1 ppm
1517 hrs	Camel Road	AKO	0.1 ppm
1520 hrs	Hartmann Road traffic lights	None	0.1 ppm
1524 hrs	Connaught Road under DLR Bridge.	None	<0.2 ppm
1610 hrs	On North side of Royal Albert Dock, West end outside YI BAN Restaurant. Wind easterly.	None	0.0
1617 hrs	Footpath behind Jet Centre blast deflector wall.	None	0.1 ppm
1619 hrs	Airport Roundabout Connaught Bridge.	None	0.1 ppm
1621 hrs	Small Ex jet started engines in front of Jet Blast wall. On foot path immediately behind section of wall (in full vibration) no smells, PID 0.1 – 0.0 ppm. This demonstrated again the efficiency of the Jet Blast wall in dispersing emissions and preventing any detection of “airport odour” directly behind the wall.	None	<0.1 ppm
1630 hrs	Left the Airport Roundabout – return to Terminal.		
1653 hrs	Hartmann Road Traffic lights: PID = 0.1 – 0.2 ppm on passage of lorries and busses, but not taxis or cars.	None	<0.2 ppm
1702 hrs	Newlands Road: smell but PID still 0.1 ppm.	Faint AKO	0.1 ppm
1708 hrs	Back to car in Short Stay car park.	None	0.1 ppm
1800 hrs	Short Stay car park. (Bright Sunshine)	None	0.0
1809 hrs	Hartmann Road above school playground.	Faint AKO	<0.1 ppm
1814 hrs	Camel Road / Hartmann Road.	Faint AKO	<0.1 ppm
1816 hrs	Between Hartmann Road traffic lights and DLR bridge.	AKO	<0.1 ppm
1820 hrs	Jet centre gate	None	0.1 ppm
1822 hrs	Airport Roundabout/Connaught Road.	AKO	0.4 ppm
1825 hrs	Airport Roundabout Connaught Road. Strong AKO but only in the gap between the Jet Blast wall and the building.	Strong AKO	<0.2 ppm
1835 hrs	South west corner of Royal Albert Dock. Wind Umax = 4.4 m/s U average = 3.3 m/s Temperature 11 degC.	None	0.1 ppm
1846 hrs	Footpath to Airport Roundabout and continued back to Terminal.	None	0.1 ppm
1915 hrs	At Short Stay car park PID = 0.1 ppm. Shut down.	None	0.1 ppm

**Tuesday 30<sup>th</sup> June 2010**

Equipped with:

- RAE systems ppb RAE 3000 PID,  
(Lowest reading 1 ppb, correction factor for jet fuel A-1 (JP-8) aviation fuel (MW 165) = 0.67
- From XC Weather: Pressure 1020mb, Wind data 14 -15 mph SW to W, 12mph later. Initially Cloud at 2,400 ft, 17<sup>o</sup>C, with dew point 9<sup>o</sup>C, later pm no cloud below 5,000 ft and 25<sup>o</sup> C, by 1530 hrs 22<sup>o</sup>C.

1030 hrs            At up-wind position at Quayside ½ way down Long Stay car park Wind SW varying in direction from SW to W, Maximum gust speed U<sub>max</sub>= 4.6m/s average wind speed U<sub>av</sub>= 3 m/s. Temperature 21.70C. Faint molasses odour detectable, possibly originating from Tate & Lyle Works.

Time	Location/Observations	Odours	PID ppb	PID ppb Zero Drift Corrected
1120	Short Stay car park, zero calibration	None	0	0
1123	City Aviation House, Reception Area (inside)		25	25
1125	City Aviation House Outside front door	None	0	0
1129	Flags Area, fluctuations		0 – 10	<10
1130	Terminal; between outside and inside doors.	None	450	450
	Terminal; booking hall	None	600	600
	Terminal; near the book store		800	800
	Terminal; near International Arrivals door		650	650
	Terminal; outside doors (readings decreased slowly)	None	0	0
1140	Hartmann Road: concentrations at zero until section between wall to south and DLR to north with little cross wind, VOC associated with traffic movements	None	9 – 25	<25
1142	Hartmann Road Camel Road junction (more open situation)	None	0	0
1144	Hartmann Road vehicle queue for traffic lights	None	30	<30
	Traffic lights with free flow of traffic	None	0	0
1145	Connaught Road (west side) under DLR bridge 50 ppb	None	50	<50
1148	Airport Roundabout pavement east side overlooking Jet Centre apron (still up wind of any aircraft activity)	None	20–100	<100
1150	On footpath west of Jet Blast Screens	None	70	<70
1152	Footpath: north end of Jet Blast Screen	None	<4	0
1154	S. Quayside area Royal Albert Dock, intermittent strong smell of odour masking agent – “Deodorizer”	Deodorizer	76	<70
1155	S. Quayside Royal Albert Dock near RIB recognisable smell	Deodorizer	100	<85
1157	North Quayside west end of Dock	None	<100	<85
1200	Royal Albert Dock north quayside between Regatta Centre and Newham Building. U maximum = 5.3 m/s U average = 4.0 m/s		30	<20
1205	North quayside west of Newham Building: edge of odour plume		70	<60
1205	Newham Building: Outside south doors	None	20	0
	Newham Building: Inside Atrium south side	Building	50	30

	Newham Building: East Wing	Building	120	100
	Newham Building: Toilets (air freshener being used)	Air freshener	200	180
	Newham Building: Atrium (north side)	Building	80	60
	Newham building outside north doors	None	50	30
1214	Newham Building car park east entry gates	None	40	<20
1216	Quayside AQC Air Quality Monitor (back on odour plume)	Deodorizer	28	<10
1220	Eastern limit of quayside footpath Noted that runway wind sock at this time showed wind direction to be WSW (still in the odour plume)	Deodorizer	30-40	<20
1225	Eastern limit of quayside path: U maximum = 5.7 m/s Deodorizer smell persistent Wind swing SW AKO smell of short duration	Deodorizer followed by faint AKO	30-40	<20
1230	Quayside, Newham Building South Doors; short duration During AKO smell	AKO	50	30
1230	Quayside, Newham Building South Doors; short duration Before and After AKO smell (no smell of deodorizer)	None	30	<10
1235	Wind swinging SSW with aircraft landing	None	20	0
1236	Quayside, west end of Newham Building	Deodorizer	60	40
1246	Quayside, west end of Newham Building, Strong smell	Deodorizer	130	120
13001306	Quayside, Belfin's Café Wind swing to W remaining several minutes (background concentrations)	None	30	<10
1307	Quayside, Belfin's Café: inside the deodorizer plume, persistent smell. Short surge of AKO	Deodorizer + AKO	242	<210
1309	Quayside, Belfin's Café: second surge of AKO within deodorizer plume	Deodorizer + AKO		
1312	Quayside, Belfin's Café: inside the deodorizer plume	Deodorizer	2,500	2,470
1314	Quayside outside Newham Building	None	32	0
1325	Quayside AQC Air Quality Monitor	None	30– 32	0
1330	Quayside outside Newham Building	Deodorizer	36	<5
1335	North quayside ventilation house vents	None	32	0
1336	Footbridge,	Deodorizer	47	15
1339	East end of Royal Victoria Dock: quayside	Deodorizer	68	40
1344	Footpath upwind	None	50	20
1345	Airport Roundabout traffic? (no deodorizer smell)	None	80-125	<95
1347	Jet Centre Roundabout south side	Deodorizer	80-100	<95
	Hartmann Road Traffic Lights	None	47	<10
1350	Hartmann Road / Camel Road	None	50	<10
1352	Camel Road near Parker Street	Curry	70	30
	Camel Road / Parker Street	None	45	0
1355	Drew Road Entrance to Airport	None	40	0
1356	Newlands Street	None	40-50	<10
1359	Set down Pick-up area	None	40s	0
1400	Short Stay car park van passing, peak	None	160	<10
1404	Short Stay car park, no vehicle movement,	None	52	10
1407	Zero check for zero drift,	None	<10	<10

### Afternoon Survey: “Car drive-around”

Time	Location	Odours	PID ppb	PID ppb Zero Drift Corrected
1440	Newham Building: Regatta Car Park Entry Instrument zeroed	None	0	0
1445	Millman Road (south end barrier)	None	0	0
	University of East London entrance barrier	None	0	0
1503	John Knights Ltd Works (entrance), Knights Road (animal rendering plant) characteristic identifiable odours.	Rendering odours	30	30
1507	Entrance to Nuplex Resins, Akzo Nobel Nippon Paints, Cromadex, PPG Industries (UK) Ltd. Characteristic paint smells.	Paint odours	40	40
1510	NE side of Docks Road by Roundabout: Characteristic landfill gas smells	Landfill odours	40	40
1515	Britannia Village, Rayle Rd (north)	None	0	0
1520	Rayle Rd, Junction with North Woolwich Road	None	20	
1524	North Woolwich Road, Pontoon Dock Traffic lights	None	20	20
1528	Airport Roundabout west side, (upwind of road) strong smell of odour masking agents - deodorizer	Deodorizer	70	60
1534	Williams Environmental Site Vehicle park, Charles Street	Deodorizer	900	890
1538	Williams Environmental Site entrance gate		3,500	3,500
1540	Hartmann Road, outside KVG House, zero calibration	None	10	0

### Conclusions

Source of “masking agent” odours was identified as likely to be Williams Environmental Management Ltd, Hazardous Waste Transfer Site, Unit 3, Charles Street Silvertown E16 2BY, producing recognisable odours to distance of over 1,000 m downwind.

Other Potential VOC/odour sources include the sites occupied by: Akzo Nobel Resins and John Knights Ltd (renderers) – see Figure A2.

General background levels in vacant open areas around London City Airport: 0 ppb

Typical values on roads of area: 20 -30 ppb

Odour threshold of AKO: best estimate: <20 ppb.