

Cleaner Air 4 Schools – Schools Audits

London Borough of Richmond upon Thames

April 2017 – August 2017



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Executive Summary

Air pollution is recognised as a major contributor to poor health with more than 40,000 premature deaths attributed to poor air quality across the UK each year, and an associated annual health cost to society estimated to be £15 billion. This has often been framed with a particular interest in protecting vulnerable groups such as young children, whose developing lungs make them particularly susceptible to pollution. A study commissioned by Sadiq Khan earlier this year showed that 802 schools, nurseries, and colleges were within 150 metres of an area breaching the annual objective limit for air pollution¹.

The London Borough of Richmond Upon Thames (LBRuT) ran the Cleaner Air 4 Schools (CA4S) project, designed to engage school children and educate them on air quality. Underpinning this project was an audit of three primary schools in the borough – Queen’s Church of England Primary School, East Sheen Primary School, and Darell Primary School. These schools were chosen for a number of reasons, including parents’ concerns and the proximity of the schools to areas of high pollution, as identified by Richmond Council’s continuous air quality monitoring.

The Council partnered with the London Sustainability Exchange (LSx) to deliver the engagement and educational aspects of the Cleaner Air 4 Schools programme. The aim of this was to educate children about the causes and effects of air pollution on health and inspire them and their parents to be aware of the changes they can make to reduce both their contribution and exposure to air pollution. This may involve adopting more sustainable and healthy means of transport such as walking and cycling, and taking less polluted routes.

It is important to note that all results gathered for this report represent only a snapshot of air quality around each school. Air quality is highly variable and is impacted by factors from local, national, and even international sources. The focus of this report, therefore, will be on providing a series of practical and actionable recommendations which can ensure that pupils are exposed to lower levels of air pollution, safeguarding their health and wellbeing.

The Cleaner Air 4 Schools Audits involved:

- Engaging with schools to establish walking routes, methods of transport, and other insights
- Monitoring air quality within schools and their playgrounds
- Monitoring air quality along children’s walking routes to school
- Mapping air quality and alternative routes to school
- Creating visual media including banners and posters to raise awareness
- Evaluating the outcomes in order to develop recommendations

As well as documenting project activities and results, this report sets out the major challenges found at each school, in addition to an analysis of the current school travel plan, and provides recommendations to improve air quality and reduce children’s exposure to pollution.

¹ <https://www.theguardian.com/uk-news/2017/feb/24/revealed-thousands-of-children-toxic-air-london-nitrogen-dioxide>

1. About the Project

1.1. Project Aims

The aims of the project were as follows:

- To understand the air quality around each school, in the context of local geography and infrastructure.
- To understand how children are affected by air quality issues...
 - Indoors;
 - outdoors (playground and school entrance);
 - and on their routes to school.
- To create awareness of the impact of air pollution on health.
- To increase awareness and understanding of air pollution issues throughout the school community, including parents, teachers, pupils, and governors.
- To gather evidence to inform further interventions.

While this report focuses on the audits and their results, rather than definitive solutions, the evidence collected should clearly point towards future interventions which can improve the health and wellbeing of the schoolchildren concerned.

Headline facts and figures about air quality in the London Borough of Richmond upon Thames can be viewed in the appendices. The council are aware that there are exceedances of air quality limits within the borough and are working hard to tackle this issue. Full details of the council's actions and [objectives to tackle air pollution can be viewed here.](#)

1.2. Project Process and Methodology

Table 1: Actions conducted

Phase	Action	Method
Research	Survey roads around school	Desk-based research
	Layer over King's College data	Desk-based research
	Information on boilers and other school infrastructure	Desk-based research

Measurement	Audit of emission sources in and around school	Site visit
	On-site monitoring, carried out by LBRuT officers and air quality champions	Diffusion tubes and instant feedback equipment
	Monitoring of surrounding area / walking routes, carried out by LBRuT officers and air quality champions	Diffusion tubes and instant feedback equipment
Evaluation	Analysis carried out and recommendations created, optionally involving champions	n/a
	Stakeholder feedback and local expert knowledge incorporated into recommendations	Stakeholders consulted throughout project
	Recommendations presented to key stakeholders such as PTA, Governors, other parents, head teachers, local neighbourhood forum	Site visit, optionally followed by phone calls – <i>to be conducted after report is published</i>

NO₂ Diffusion Tube Monitoring

Nitrogen dioxide (NO₂) is one of two major pollutants of concern in London. Diffusion tubes are widely used in the UK and provide a monthly average of ambient concentrations of NO₂. The



Figure 1: An example of a diffusion tube, mounted to a lamppost

technology is relatively simple and has been used for a number of years; an example of a diffusion tube can be seen in Figure 1. Officers from Richmond Council placed a network of diffusion tubes around the three schools concerned (35 tubes in total). The diffusion tubes were put up on 18 July 2017 and were taken down for analysis on 16 August 2017, giving an average reading over four weeks. The majority of this time period was during school summer holidays, and so we would expect readings to be lower than during term time.

This provides us with an excellent opportunity to repeat this research in the near future to establish the role that school

parents' travel methods play in air quality. The placement of diffusion tubes varied and this will be explained in further detail in relation to each school. Additionally, working in small teams, pupils used diffusion tubes to gather data in March and April 2017, engaging them in the audit process and increasing their awareness of environmental issues and monitoring techniques. The measurements taken for this project provide a snapshot, looking only at particular periods of time. Pollution varies seasonally and can be affected by one-time events and thus the data gathered, which can be viewed in its raw form in the appendices, does not provide an annual picture.

Particulate Matter (PM₁₀ and PM_{2.5}) Monitoring

Particulate Matter is the other major air pollutant of concern in London. Studies have linked it to bronchitis, sinusitis, frequent colds, exacerbated asthma symptoms and reduced lung function in children². Certain categories of particulate matter (particularly related to diesel exhaust fumes) have been shown to contribute to incidence of lung cancer³. Negative health effects from exposure to particulate matter have been recorded even below the limit defined by the EU⁴, and so there should be a concerted effort to reduce overall levels of particulates in the air.



be

Figure 2: The equipment used to measure PM_{2.5} and PM₁₀

Particulate Matter was measured along the same routes the diffusion tubes were placed along. Monitoring took place along school routes between 8.15am and 8.45am during term-time, when children were walking to school. Additionally, monitoring was carried out within the school site during morning break time, both in strategically located classrooms and various points in the playgrounds. The equipment used can be seen in Figure 2; it takes an on-the-spot air sample over a 60 second period and analyses it, providing a result for PM_{2.5} and PM₁₀ in µg/m³. Particulate matter can be affected by weather, with rain removing and washing away particulates in the air and wind dispersing it. Hence, all readings were taken on clear, calm days, with no rain on the preceding day. The full list of measurements of particulate matter can be found in the appendices, and are explored in detail and interpreted for each school in Section 2. As with the NO₂ monitoring, it is important to maintain an awareness that these results provide a snapshot of a particular moment, as opposed to annual data. Particulates in the air are affected by a wide range of factors including weather, traffic, and even dust blown over from the Sahara desert; thus, particulate matter levels will inevitably vary.

Mapping

Based on the data gathered via mobile monitoring and diffusion tubes, maps were created which focus on the school sites and the surrounding area. Local knowledge and engagement work within the school, carried out by the London Sustainability Exchange (LSx), provided information about the routes most travelled by students in each school. These routes were ranked by pupils according to the perceived levels of safety, air pollution, noise, ease of crossings and things to see and do along the route. Using this information, routes were identified for monitoring. The approach taken varied by school, dependent on the area and the predominant method of travel. For example, at Darell Primary School, many parents arrive by car, parking in Sainsbury's car park and walking their children to the school gate. A comparison was therefore provided between stopping a vehicle in the car park, and stopping a vehicle at a different location which provided a walk through a local park instead. Conversely, in Queens Church of England Primary School, regular walking routes to school were monitored from a number of residential locations, and these were compared to alternative routes which were identified as likely experiencing better air quality.

² http://www.euro.who.int/_data/assets/pdf_file/0005/112199/E79097.pdf

³ [http://www.thelancet.com/journals/lanonc/article/PIIS1470-2045\(13\)70279-1/abstract](http://www.thelancet.com/journals/lanonc/article/PIIS1470-2045(13)70279-1/abstract)

⁴ <http://www.medscape.com/viewarticle/807579>

In-School Education and Engagement

London Sustainability Exchange conducted research and engagement work within the primary schools as part of the CA4S programme. LSx has worked extensively with primary and secondary schoolchildren and the Cleaner Air 4 Schools programme aims to improve the confidence, knowledge and skills of both pupils and the wider school community of parents, teachers, and governors. This includes helping them understand the importance of air quality, the main causes of air pollution, and actions that can be taken to tackle it.

Surveys were conducted in classrooms to establish a range of contextual information such as the routes children walk to school, their method of travel, and the preferred method of travel of both pupils and parents. Air Quality Champions also took part in traffic and idling surveys, counting vehicles during a specified time period outside the school gates. This was carried out in conjunction with PM₁₀ measurements to create an accurate picture of conditions outside the school.

Posters

Pupils created posters to raise awareness of the issues they had learned about, and to encourage their parents to make conscious decisions to reduce pollution around the school; this demonstrates the pupils' level of engagement in this project. Figure 3 below shows a banner, created from the school pupils' anti-pollution posters, displayed outside Darell Primary School.



Figure 3: Posters designed by the pupils of participating Richmond schools, outside Darell Primary School

1.3. Additional Monitoring and Evaluation

The following quantitative and qualitative methods were outlined to collect data to ensure project aims and objectives were met:

Table 2: Monitoring and Evaluation Activities

Data to be collected	Data type	Method	Outcomes
Number of people reached	Primary quantitative	Number of pupils	Approx. 100
Number of Air Quality Champions	Primary quantitative	No. of pupils / community members that become leaders	4 pupil/ community member champions per school
Travel mode	Primary quantitative	Baseline and follow up show of hands; take-home survey	60% response rate
Traffic data	Primary quantitative	Counting cars during classroom citizen science activities (when putting out diffusion tubes)	Traffic count completed and data used
Air Quality measurements	Primary quantitative	NO ₂ , PM readings and lichen observation	<i>See report for measurements</i>
Leaflets / posters / banners distributed	Qualitative data	Material produced	Posters created and distributed
Awareness / understanding of air quality issues	Primary qualitative data	Survey	Increase in awareness / understanding of air quality issues
Preferred travel mode	Primary qualitative data	Survey	Shift in preference

Table 3: Outline of surveys (primary qualitative data collection method) to be used in the project

Survey	Audience	Purpose	Timing	Method	Success
Baseline survey	a) Parents of target year groups b) Other parents	Gauge current travel behaviours, plus perception and knowledge of air quality	1-2 weeks before LSx intervention at school	Paper / digital surveys sent home	a) 60% response rate b) No criteria
Show of hands survey	a) Whole school b) Target year group(s)	Establish travel behaviours for the whole school	At the beginning of school assembly	Show of hands	n/a
Follow up survey	a) Parents of the target year groups b) Other parents	Document changes following LSx intervention at school	Post-project (September)	Hard/ Electronic surveys sent home	a) 60% response rate b) No criteria
Show of hands survey	a) Whole school b) Target year group(s)	Document changes to travel behaviours in whole school	Post-project during report writing or during presentation of recommendations	Show of hands to fill in form (In classrooms / In the final presentation assembly)	n/a
Walk to School Day	a) Whole school b) Target year(s) c) Parents and teachers of target year(s)	To encourage walking to school instead of more polluting transportation	Periodically throughout the project (3 days)	Each year walks with teachers. Different route for each class	n/a

2. Individual Schools

This section details the work carried out at each school. The three schools chosen by Richmond Council were The Queen's Church of England Primary School, East Sheen Primary School, and Darell Primary School. Each school received the same activities and support, whilst the air quality audits were tailored to each school. At the Queen's School, an eco-audit looked at building emission sources, in addition to the other activities.

2.1. The Queen's CE Primary School

2.1.1. Background and Context

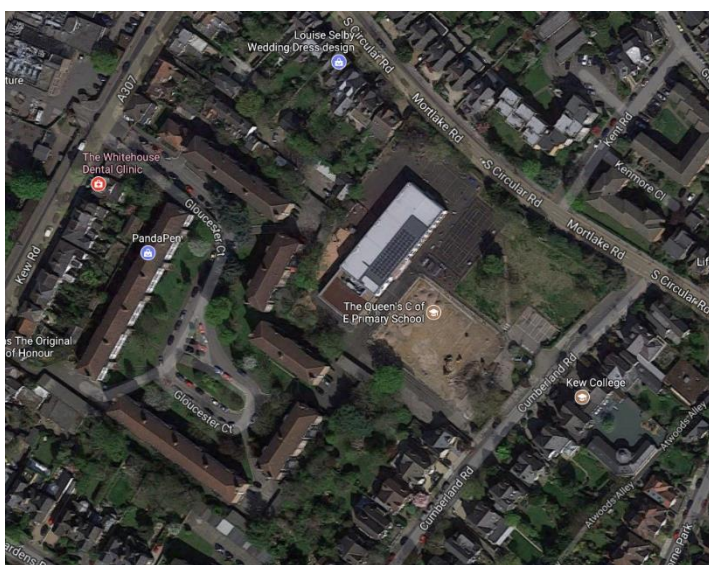


Figure 4: An aerial photograph of Queen's School, Kew

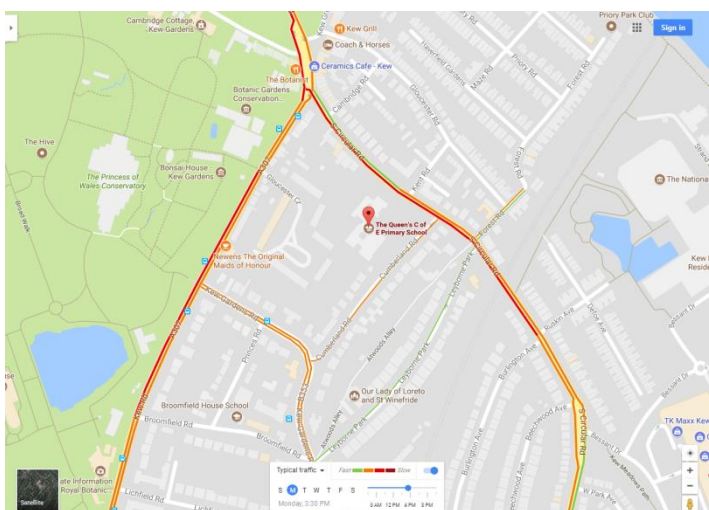


Figure 5: Google Maps displaying typical traffic - Monday 15.30 August 2017

A new 3G sports pitch has also been constructed between the school's main building and Cumberland Road.

The Queen's School, Kew, is a Church of England primary school in the London Borough of Richmond upon Thames. It is a Voluntary Aided two-form school in the parish of St Anne's. The main entrance is located on Cumberland Road, a one-way street which is mainly residential (and can be seen in the South East of Figure 4). However, the entrance to another school (Kew College) is located directly opposite that of Queen's School, causing a lot of congestion along this road during school pick-up and drop-off times. The school also faces a very busy road (Mortlake Road – the South Circular) and is close to where two heavy-traffic roads converge and traffic queues (which can be seen in the Northern portion of Figure 5). These busy roads also have fairly high levels of air pollution which can be seen in the modelling data in Figure 6.

The school has recently undergone construction and remodelling, moving the main building further from the roads. Currently, a tarmac playground faces the South Circular, separated from the road by a chain-link fence. A

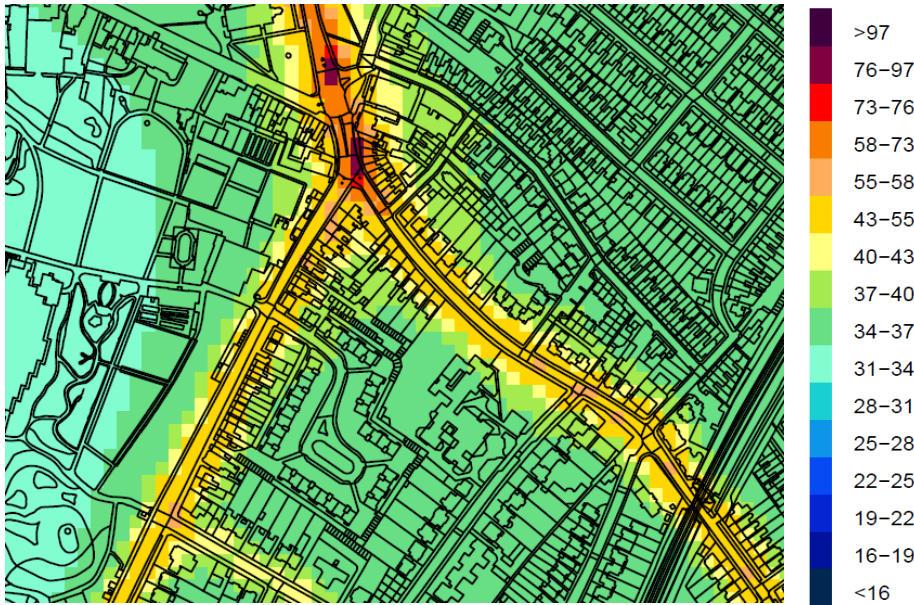


Figure 6: Map showing modelled NO₂ pollution concentrations for 2013 for Queen's Primary School. Modelling carried out by ERG, King's College London.

2.1.2. Activities and Results

NO₂ Measurements

The map in Figure 7 on the following page displays the NO₂ results for walking routes to/from Queen's Primary School in Kew. Markers coloured green represent a monthly average of <math><30\mu\text{g}/\text{m}^3</math>. Values represented in orange are $30\text{-}40\mu\text{g}/\text{m}^3$, and values with red markers are over the annual EU limit of $40\mu\text{g}/\text{m}^3$. For the full results of all routes and their exact values, please see the appendices. Figure 7 identifies three starting locations (each labelled A); the majority of children come from these directions when walking to school. From each of these three locations, two routes to the school were identified, one being along larger roads, which is what many children and parents tend to do, and the other one being along quieter roads. The three comparison areas have been labelled 1, 2, and 3 to distinguish them.

Although results vary there is a clearly defined disparity which can be observed between the comparison routes. When looking at the two routes taken in Area 1, one can clearly see a notable difference in results, with the quiet backstreets of Bushwood Road and Forest Road registering levels of $15.97\mu\text{g}/\text{m}^3$ and $15.26\mu\text{g}/\text{m}^3$ respectively, compared with readings along the South Circular of $40.05\mu\text{g}/\text{m}^3$ and $45.69\mu\text{g}/\text{m}^3$. With high levels of NO₂ impacting the likelihood of respiratory problems, there is a clear public health benefit in marking out these routes of low pollution.

Areas 2 and 3 have less immediately visible results, however demonstrated the same principles seen in Area 1. In Area 2, pupils travelling along Kew Road (a busy road running parallel to Kew Gardens, with high traffic levels and many tourist coaches often idling their engines) would have been exposed to $33.15\mu\text{g}/\text{m}^3$ of NO₂ as compared to readings consistently below $30\mu\text{g}/\text{m}^3$ using an alternative path.

Following this, Figure 8 displays data gathered on the school site itself, with 8 of the 9 diffusion tubes registering below EU legal limits during these term-time readings. The diffusion tube which

highlighted an area of concern was placed on a bare area of fence, separating the playground from the South Circular. The diffusion tube placed along this fence produced a reading of $43.37 \mu\text{g}/\text{m}^3$, somewhat above the EU limit value. The majority of this fence has greenery planted or growing along it however there is a small patch with no protection. This high NO_2 result at that site may highlight a need for intervention.



Nitrogen Dioxide (NO_2)

monthly average:

- GREEN = $< 30 \mu\text{g}/\text{m}^3$
- ORANGE = $30 - 40 \mu\text{g}/\text{m}^3$
- RED = $> 40 \mu\text{g}/\text{m}^3$



EU Legal Limits:

$40 \mu\text{g}/\text{m}^3$ (over 1 yr)

$50 \mu\text{g}/\text{m}^3$ (over 24h)

Figure 7: A map showing NO_2 levels along walking routes to/from Queen's Primary School, Kew

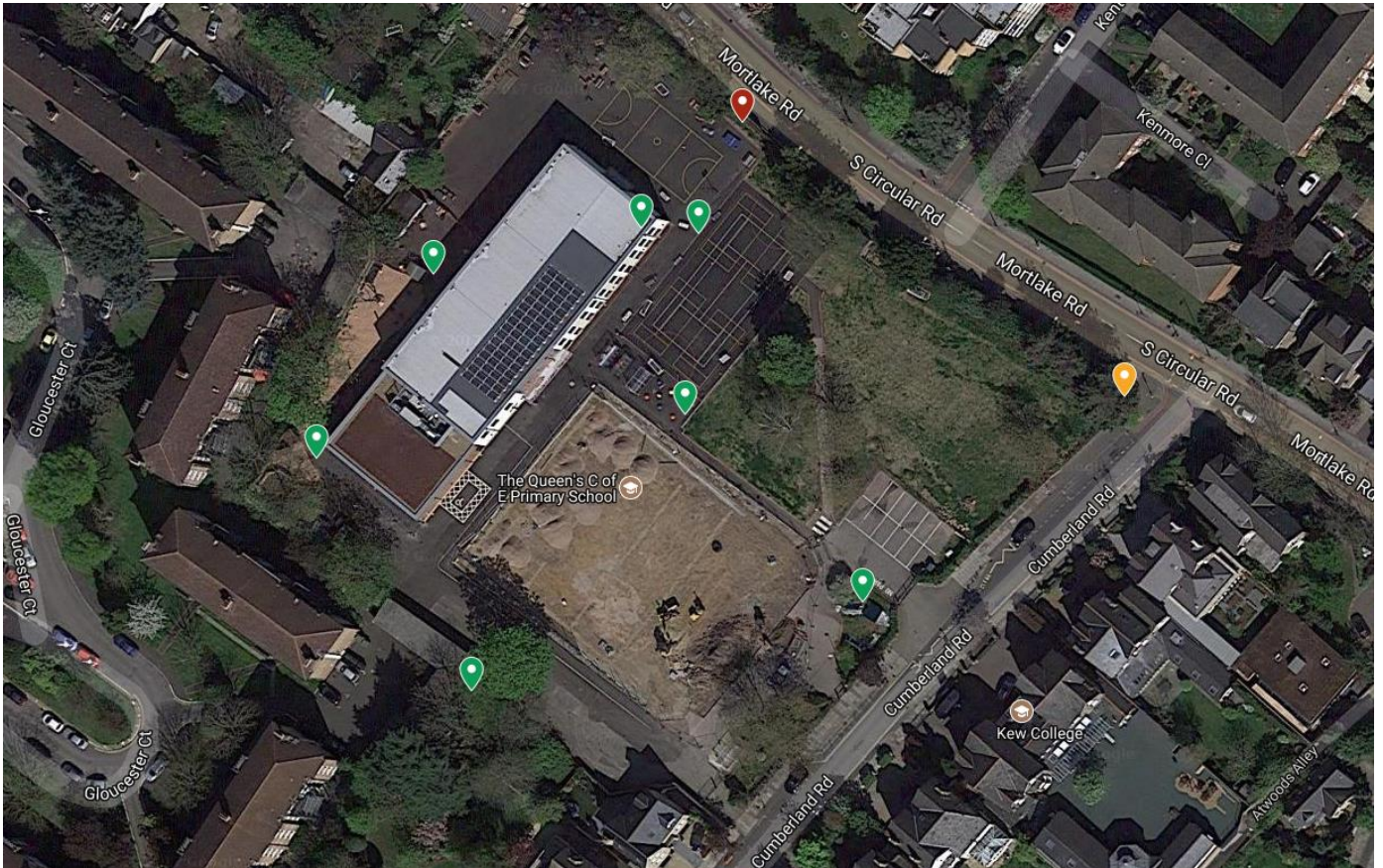


Figure 8: A map showing NO₂ levels around the site of Queen's Primary School, Kew

Particulate Matter Measurements

Particulate matter is simple to measure however its variation over seasons, days, and even hours makes it very difficult to provide an overall picture of the levels of particulates. This being said, the data gathered provides an excellent comparison between walking routes. All PM_{2.5} data gathered around Queen's Primary school was significantly below the limits set by the European Union, however, in spite of legal limits and target values, there is not considered to be any 'safe' concentration of particulates. Therefore, the public must be proactive in reducing their exposure, whilst authorities (as well as the public) must work towards reducing the production of particulate matter.

Particulate data gathered in this study provides a useful comparison between children's walking routes, and will create a greater awareness of the impact that daily decisions have on exposure to particulates. The levels of monitored PM_{2.5} varied between 4.5 µg/m³ on Bushwood Road to 6.8 µg/m³ along the South Circular, clearly providing a preferable (from a public health perspective) walking route. Additionally, roads like Bushwood are subject to lower levels of traffic and can thus be seen as beneficial from a safety perspective as well.

With regards to PM₁₀, readings were also well below legal limits set by the European Union, with the highest result recorded in Area 1 being 14.9 µg/m³. As with PM_{2.5}, the variation seen across different

routes is clear, and can be used to inform school travel plans and educate children and parents on how to reduce their exposure to air pollution.

The data produced for all areas around Queen’s Primary School, as well as within the school site, can be viewed in the appendices. All readings of particulate matter, both in and around the school site, registered well below EU limits.

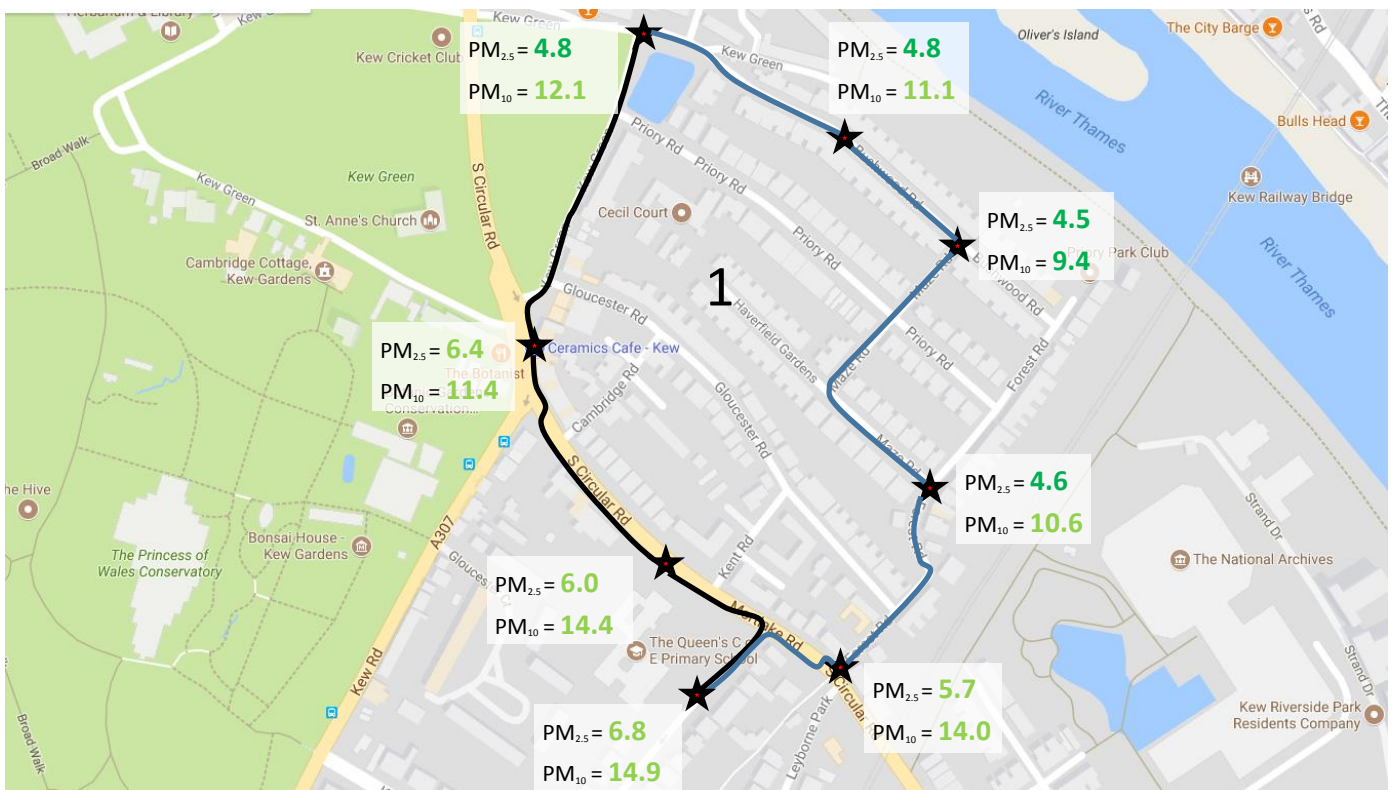
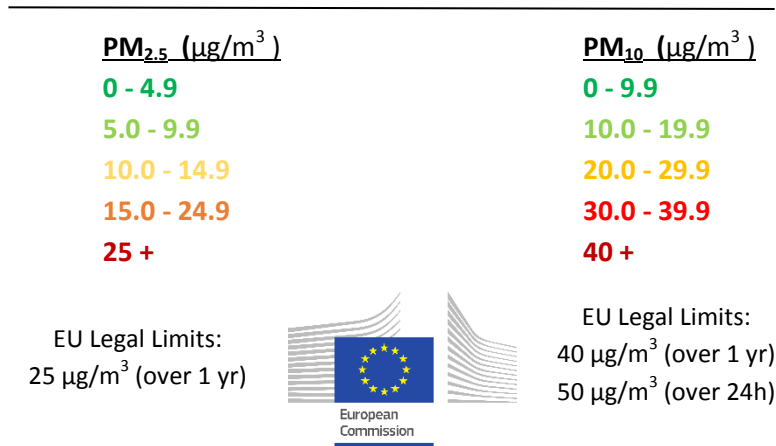


Figure 9: A map showing Particulate Matter readings for Queen's Primary School, Kew

Travel Plan Analysis

Key Findings

- 88 % (of 66 surveyed) already travel sustainably to school, with the majority walking
- Pupils expressed a strong desire to cycle to school
- Mortlake Road, to the North of the school, forms part of many pupils' routes to school and showed high levels of pollution
- The main concern for parents is safety
- Concern about pollution was mentioned as a minor factor in travel choices
- Those who choose to drive tended to mention comfort as a determining factor, rather than distance
- See Section 2.1.3 for overall conclusions from Queen's Primary School
- The Queen's School has a Travel Plan in place, and was awarded bronze level by the TfL STARS⁵ scheme in September 2016. Analysis of the travel plan and additional research and observations yielded the following information:

Issues outlined

- Cumberland Road is overcrowded at drop-off and pick-up times
- Cars often park illegally
- Drivers do not adhere to the speed limit (20mph through Cumberland Road)
- Community members want to know how to improve road safety

Good practices the school has adopted

- The zebra crossing and improved signage which have been put in place in response to previous recommendations
- The availability of staff shower facilities, and three covered bike stands, encouraging staff to cycle to work
- Placement of traffic cones at pick-up times and signs which read "Parking here could endanger a child's life" directly outside the front of the school, preventing vehicles from stopping

Areas which could be extended

- The most recent initiative took place over a year ago, which means that all of the information about the projects is no longer included in this years' travel plan
- The latest initiative (23/05/2016) was about road safety talks, under the category of Walking, Cycling and Road Safety. This was migrated from the old STARS system.

⁵ <https://stars.tfl.gov.uk/About/Accreditation>

Travel preferences and behaviour

Parents completed online surveys that helped us to understand their travel methods and preferences, as well as barriers and motivations to certain travel modes. These were supplemented by a hands-up survey for the Year 4 pupils.

Figure 10 on the following page shows the results from a survey of 66 respondents who were asked how they travel to school. 88% of respondents travel sustainably on foot or by bicycle and so the data gathered demonstrated the importance of highlighting preferred routes for this group. The findings were mostly consistent with those in the School Travel Plan⁶ in terms of the current methods of travel. However, it is notable that those who drove to school were not affected by how far away they live, suggesting other reasons for driving rather than using alternative methods of travel. Speaking with parents and pupils showed strong perceptions of driving as being more 'convenient', something which was echoed in findings from the other schools.

"I do already walk which is important to me for fitness and environmental reasons. When I use the car it is for time and convenience reasons."

"I have two children to drop off at two different locations and the only manageable way is driving."

Above are some extracts from interviews with parents about their travel methods, highlighting some of the barriers that need to be considered and overcome when encouraging people to walk to school rather than driving. Figure 11 shows, however, that the majority of those who drive to school would prefer not to. Pupils would mostly choose to cycle or use scooters, rather than walking. For parents, safety was overwhelmingly the reason for not cycling. This was reflected in discussions and in survey results.

"A cycle lane would enable many more children to cycle to school safely"

"I would try [cycling] if there were clear cycle lanes. At the moment it just appears too dangerous with the amount of traffic and no real cycle lanes"

One third of the 66 parents surveyed regarded time and money as important factors when considering the school commute. This is contrary to some pupils' clear vision of the trip to school as valuable and interesting in itself, with money not playing any role in children's decisions.

⁶ Stars London Borough of Richmond upon Thames The Queen's Church of England Primary School Travel Plan 09/01/2014-31/05/2017

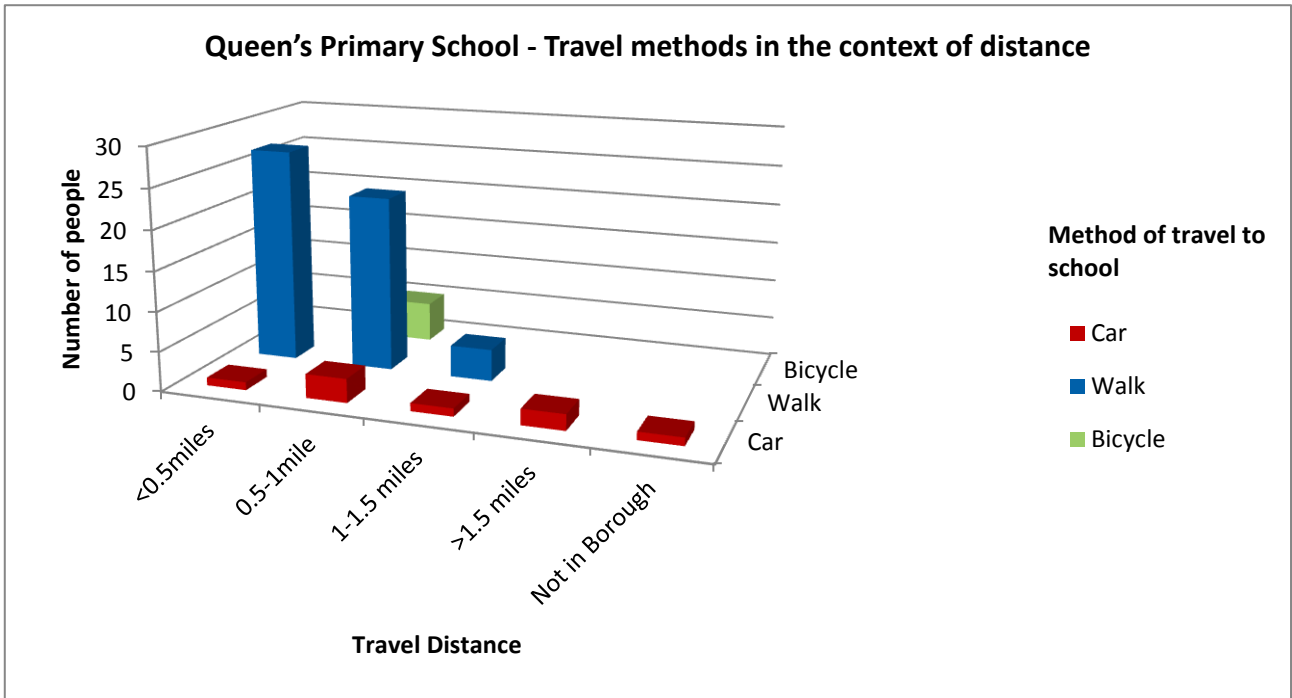


Figure 10: Results from online survey about parents' travel methods to school, 2017 (66 respondents)

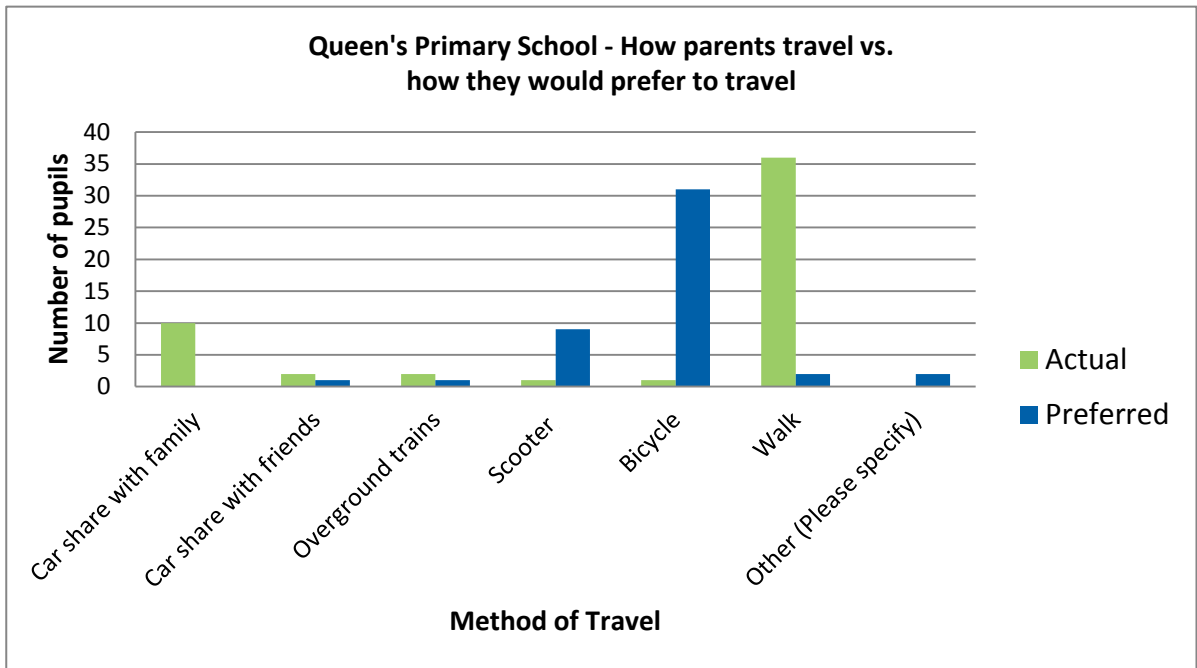


Figure 11: Pupils' actual vs preferred method of travelling to school (52 respondents)

2.1.3. Conclusions and Recommendations

Levels of pollution within Queen's primary School were not excessively high compared to legal limits, apart from the fence connecting the playground to the South Circular, which exceeded the European Union's limit for NO₂. With regards to walking routes to and from the school, there are clear benefits to taking certain paths, and this will be explored below. Although many of the readings returned results which are below legal limits, lower concentrations of particulate matter can still have adverse health effects, especially on young lungs, and so there is work that needs to be done to lower these levels wherever possible. Both the local authority and school have made commendable efforts to instigate programmes around safety and cycling in particular and these should be continued and extended, with particular focus on motivating parents into action.

School site and immediate area recommendations

- There is a gap in the foliage covering the fence next to the playground, which backs on to a busy road (Mortlake Road / South Circular), where the highest levels of pollution and traffic were recorded. Considering the time children spend in the playground, this gap should be closed in order to provide a better barrier to particulates and nitrogen dioxide, as well as creating a more pleasant environment. This can be done with the provision of greenery which will work to absorb NO₂ and act as a barrier for particulate matter.
- Cumberland Road becomes very congested during school start and finish times, with many parents attempting to pull over as near to the school as possible, often leaving their engines running in the process. More engagement should be conducted with pupils' parents to make them aware of the adverse health effects of vehicle emissions and encouraging them to consider how their decisions will impact their own children. If the situation does not improve, the local authority could consider alternative interventions such as timed road restrictions.
- As there is another school on the same road (Kew College), any campaigns or interventions apart from those within the school grounds should be carried out with involvement of both parties, and ideally residents as well.
- The final recommendation from this research is that it should be revisited periodically to map any changes and to ensure that any mitigation measures are having the desired effect. Queen's Primary School could operate its own on-site diffusion tubes as these are low cost and simple to replace on a monthly basis. The use of a small number of tubes around the school site would ease the concerns of many parents regarding air quality and could also be incorporated into the science curriculum to allow children to engage further with the subject.

Travel plan and behavioural recommendations

NO₂ and Particulate Matter data gathered in this project inform recommendations below with regards to understanding pollution and avoiding your exposure where possible

- The school travel plan should be updated and publicised to reflect air pollution data and engage with pupils to ensure they understand and embrace this change. The specifics of the findings are as follows:
 - If approaching the school from the North, one should emerge from Forest Road if possible, rather than approaching along the South Circular. The ultimate advice is to join the South Circular as late as near to the school as possible, to limit the time of exposure to its higher air pollution levels.
 - If approaching from the East of the school, one should go through the Kew Gardens Station underpass as this is the route of lowest pollution from an NO₂ perspective. This being said, the underpass registered higher levels of particulate matter due to the stagnant air, and so this should be taken into consideration also.
 - When approaching the school from the West / South-West, one should walk along Ennerdale Road, as opposed to walking along the parallel Kew Road (A307). Kew Road's higher traffic levels and idling coaches creates higher levels of air pollution, and so this should be avoided as much as is practicable.
- The school should continue promotion of sustainable travel and its benefits, as well as road safety and health talks. Consultations with pupils' parents can also help in engaging them in the process and potentially overcoming barriers they see to travelling sustainably.
- The school should continue walking activities like Free your Feet and Walk Once a Week, and introduce others such as Walk to School Month and Walking Buses to carry on the enthusiasm for those who already walk, and also to influence those who still drive to school.
- More cycling training should be delivered for pupils and parents such as Bikeability and Cycle Skills Sessions for Adults. This will build skills and confidence for safe interactions with other road users, encouraging more people to cycle to work rather than drive.
- More of a partnership should be developed with Kew College in order to tackle issues on Cumberland Road, with a joint anti-idling campaign and proposals to remove car parking.

2.2. East Sheen Primary School

2.2.1. Background and Context

East Sheen Primary School is a two-form entry community school located in the London Borough of Richmond upon Thames. The only main entrances of the school are located on Upper Richmond Road (the South Circular), which is known for its high traffic count and congestion. Naturally the traffic varies at different times of day, with the early mornings and afternoons experiencing the heaviest traffic, however traffic flow is relatively high 24 hours per day, with many



Figure 12: Aerial view of East Sheen Primary School

trucks using this route to navigate in and out of London. Classrooms are located towards the back of the school site, whilst both tarmac playgrounds face out towards the South Circular, separated from the road by a brick wall and chain link fence with some vegetation beginning to grow.

Figure 13 shows pollution modelling for the surrounding area, which casts concerns over the school's proximity to the main road and its poor air quality. This was one of the reasons East Sheen Primary School was selected for this audit.

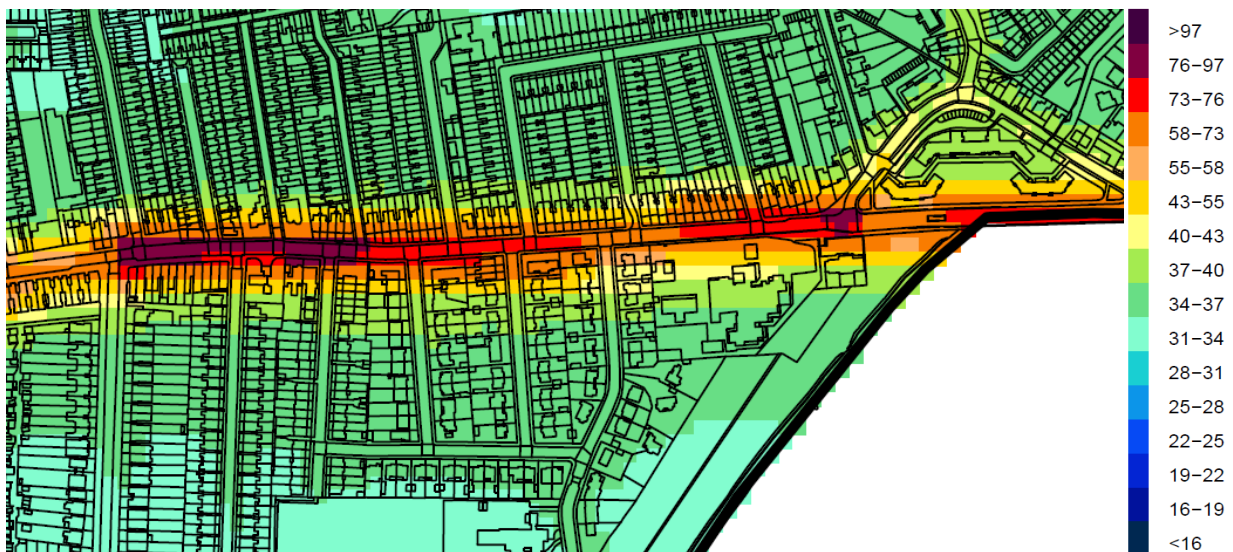


Figure 13: Map showing modelled NO₂ pollution concentrations for 2013 for East Sheen Primary School Modelling carried out by ERG, King's College London.

2.2.2. Activities and Results

NO₂ Measurements

The map in Figure 14 displays the NO₂ results for walking routes to/from East Sheen Primary School. Markers coloured green represent a monthly average of < 30 µg/m³. Values represented in orange are 30-40 µg/m³, and values in red markers are over the annual EU limit of 40 µg/m³. For the full results and their exact values, please see the appendices. Figure 14 establishes two starting locations, each marked 'A' on the map. These locations were chosen as they represented likely starting points for children walking to school, as identified by the engagement work carried out with the children. From each of these starting points, two routes were mapped out to East Sheen Primary School; one which takes the quickest route to the main road and travels along it to reach the school, and another which takes an alternative route along quieter streets.

The results of this study returned relatively low results all around, which is likely due in part to the lack of parent traffic outside of term time. This being said, East Sheen Primary School on Upper Richmond Road is the site of one of Richmond Council's permanent monitoring diffusion tubes, which has been collecting monthly data for a number of years. The results gathered for this study were lower than that of the permanent tube, demonstrating the variability of air pollution levels. The low results returned for East Sheen Primary School are an encouragement to repeat this



Nitrogen Dioxide (NO₂) monthly average:

- GREEN = < 30 µg/m³
- ORANGE = 30 - 40 µg/m³
- RED = > 40 µg/m³



EU Legal Limits:
40 µg/m³ (over 1 yr)
50 µg/m³ (over 24h)

Figure 14: A map showing NO₂ levels along walking routes to/from East Sheen Primary School

research at a different time of year to examine the impact of school travel on air quality.

The only diffusion tube near East Sheen Primary School which returned a result higher than $30 \mu\text{g}/\text{m}^3$ was that located along the South Circular nearest the school, where the road narrows and crossings slow and stop vehicles. This diffusion tube returned a result of $34.65 \mu\text{g}/\text{m}^3$ which, despite being the highest recorded reading, is still below EU set limits.

The results gathered can be used to draw comparisons between different walking routes, helping to inform school travel plans and educate parents and pupils. The levels of NO_2 along the South Circular were more than double that of other roads in the area. Whilst the lowest result on the South Circular was $28.29 \mu\text{g}/\text{m}^3$, Hertford Avenue, an alternative walking route in area 2, registered between $12.23 - 13.55 \mu\text{g}/\text{m}^3$, clearly making it the preferable option. This challenges the approach adopted by many people to find to the nearest main road and walk along it.



Figure 15: A map showing NO_2 levels on-site at East Sheen Primary School

Figure 15 above shows NO_2 readings taken on and around the school site. All diffusion tubes which were placed in and around the classroom areas returned low results, with the highest of these being $24.90 \mu\text{g}/\text{m}^3$. All tubes placed along the entrance gates registered higher responses, with one being above EU limits at $42.47 \mu\text{g}/\text{m}^3$. The drop-off in NO_2 concentration at distance from the main road is remarkably clear, with NO_2 levels dropping $18 \mu\text{g}/\text{m}^3$ between the front gate and the entrance to the school. These results demonstrate that, if possible, measures should be put in place along that section of the South Circular, and more could be done to shield children in the front playgrounds from pollution from the roads.

Particulate Matter Measurements

Figures 16 and 17, which can be found on the following pages, show the two areas around East Sheen Primary School in which particulate matter was sampled. All readings taken fall well below EU limits however this is not to say that no lessons can be learned and actions taken away. The difference in readings taken outside East Sheen Primary School demonstrates the volatility of particulate levels in the air, as these are affected by a huge range of international, national, and local factors which can often vary seasonally or even from minute to minute. Despite this variation, the disparity between results across different routes demonstrates the importance of walking routes.

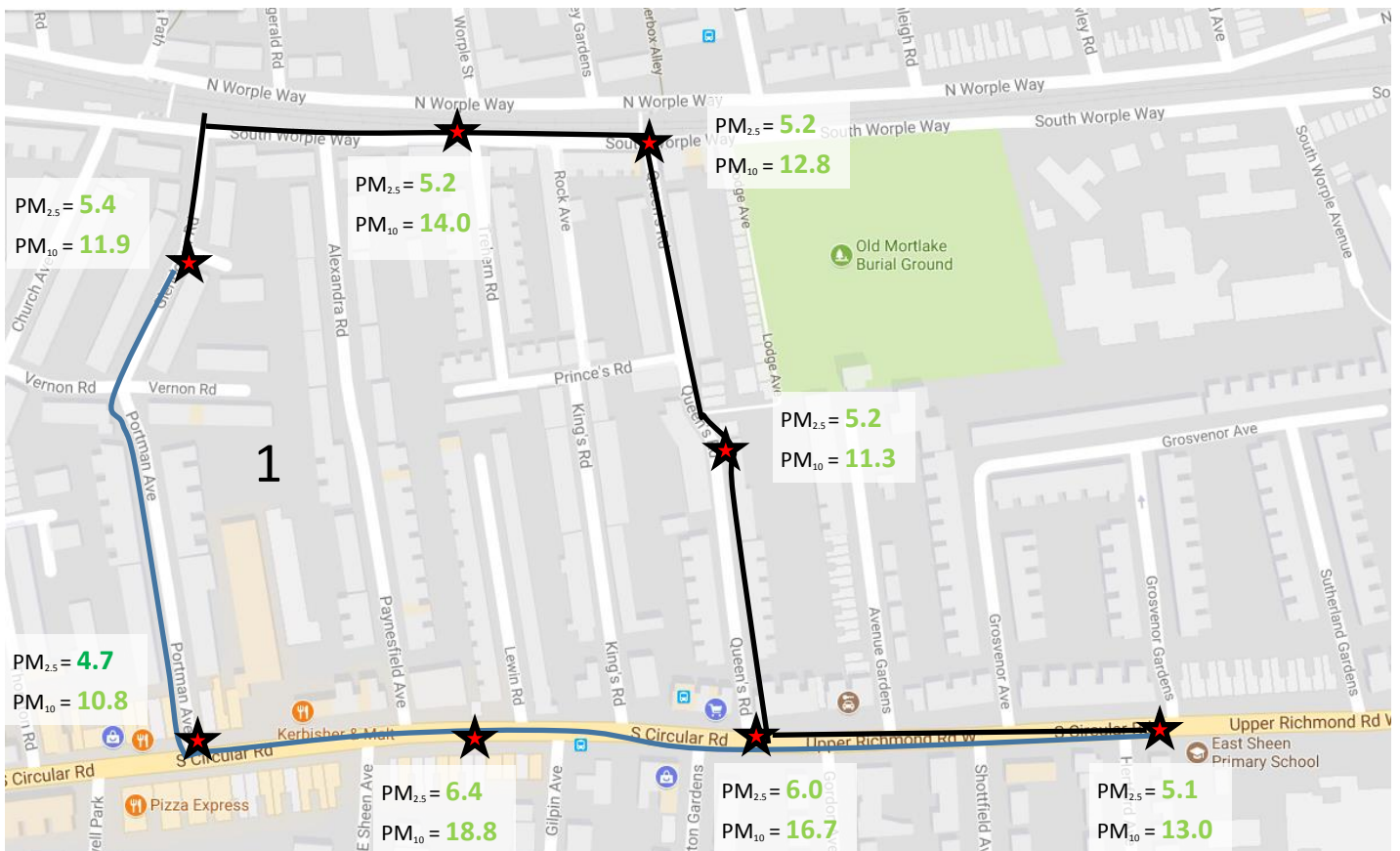
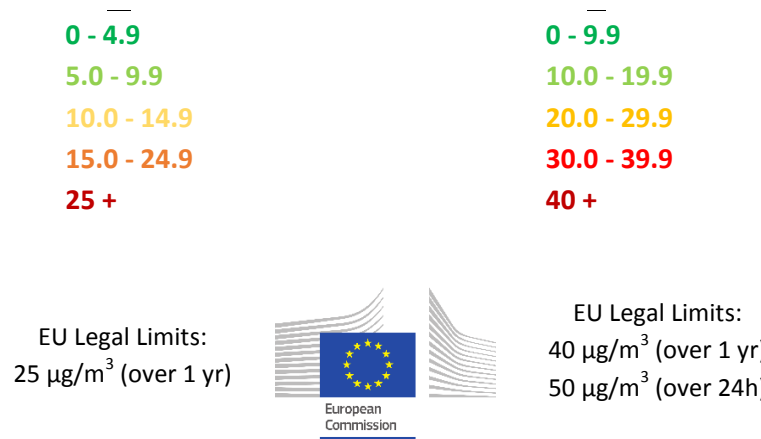


Figure 16: A map showing Particulate Matter readings for East Sheen Primary School



The levels of monitored PM_{2.5} varied between 3.0 µg/m³ on Palewell Park and 6.4 µg/m³ along one part of the South Circular, with one standout result of 12.2 µg/m³ recorded along the South Circular where the road narrows and traffic often slows. With regards to PM₁₀, readings were also well below legal limits set by the European Union. The variation between the main road and side roads, therefore, can be as high

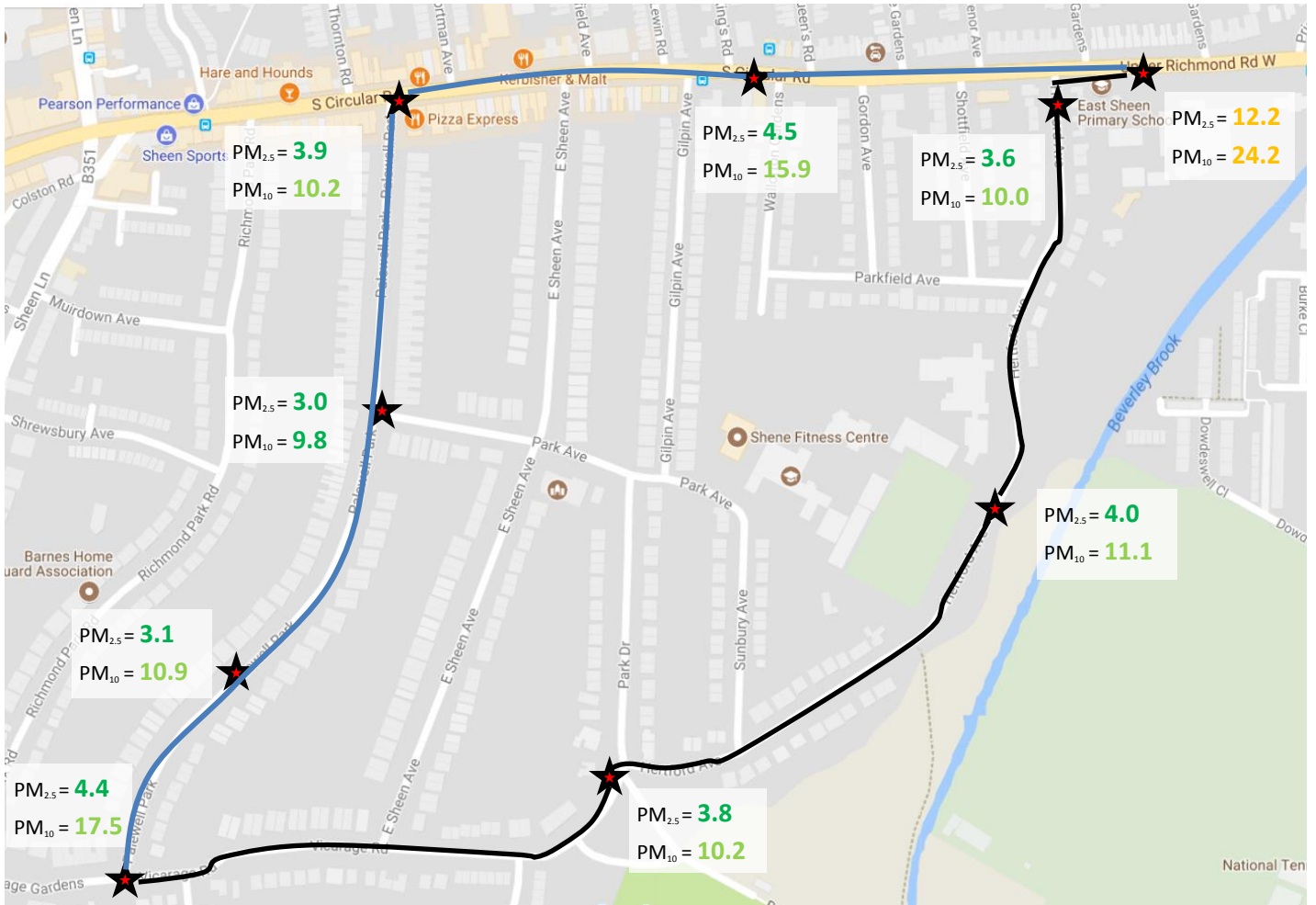


Figure 17: A map showing Particulate Matter readings for East Sheen Primary School

as high as $14.4 \mu\text{g}/\text{m}^3$ for PM_{10} and $9.2 \mu\text{g}/\text{m}^3$ for $\text{PM}_{2.5}$.

This information can be used to inform school travel plans and educate children and parents on how to reduce their exposure to air pollution, demonstrating that making a small change to everyday actions can significantly impact exposure to pollution and thus health and wellbeing. Full results and maps for East Sheen, including the school site, can be found in the appendices.

Travel Plan Analysis

East Sheen Primary School has a School Travel Plan in place, and was awarded STARS bronze level in September 2016. Analysis of the travel plan shows the following:

Issues outlined

- Broken Belisha beacon on Upper Richmond Road, a crossing which is heavily used by parents and children, identified in February 2017.
(This has since been repaired and is now fully functioning. *Correct as of October 2017*)
- Parking is an issue in this area: unsafe parking in Hertford Avenue makes residents unhappy and it becomes more difficult to cross the road.

- As the school is situated on a busy and narrow stretch of Upper Richmond Road, it is not recommended for children to cycle.

Good practices the school has adopted

- Walk to School Week: they changed the dates so that the whole school could be involved as Year 4 were away the week of the national campaign in May 2017.
- Promotion of car sharing
- Lots of initiatives to include road safety and air quality into the curriculum, e.g. walking buses for year 1, doing map work and road safety, using TfL's A-Z of Traffic Tales for reception children, safe walking training, scooter and bike training, and walking trips
- From a communications perspective, a new website has been created, and parents have been updated by newsletter following accidents on nearby roads
- Cleaner Air 4 Schools Programme: Green Team in charge of diffusion tubes after the assembly
- Cleaner Air Competition: Anti-Idling competition. Children understand what idling is and why it is bad for air quality
- Public transport is used for school trips wherever possible
- There is collaboration between parents, school management, local police and authorities to highlight issues to TfL, the Council, and the Greater London Authority (GLA)

Areas which could be extended

Audits conducted by Richmond Council officers, as well as that conducted by the GLA, could be extended; the school is already committed to sharing findings and recommendations with other schools in the locality to share best practice. This is an area which could be extended with the council's support. Play Streets or Healthy Streets initiatives would also be appropriate here.

The school held an assembly at the start of the project to introduce the topic of air quality to KS2 pupils, of which there are 320; a number of parents also attended the assembly, and 101 households took part in online transport surveys about their routes to school.

All 80 Year 4 pupils received two air quality lessons in the spring and summer terms of 2017. The first lesson included a hands-up survey of how they currently travel to school, how they would prefer to travel to school, and some of their concerns and priorities on their routes to school. In the second lesson, LSx presented the data to the entire year group with the help of Air Quality Champions. The pupils then created posters based on the findings to raise awareness about what they and their parents could do to combat air pollution around the school.

Key findings

- Children are mainly exposed to pollution outside the school gates which face the very busy Upper Richmond Road.
- Most pupils walk to school with parents; they are not contributing to pollution.
- The main concern for both children and parents was safety. Although concern was expressed about pollution it was not mentioned as a main factor in travel choices.
- Pupils want to cycle but parents view it as too dangerous

- Pupils are more concerned about pollution than parents are, though many parents did state a willingness to get involved in activities for cleaner air.

Travel preferences and behaviour

The pie chart in Figure 18 shows the composition of the traffic outside East Sheen Primary School. Over a 10 minute period 264 vehicles, pedestrians, and cyclists were recorded, with 90% being motor vehicles. More than a quarter of those were vans and lorries.

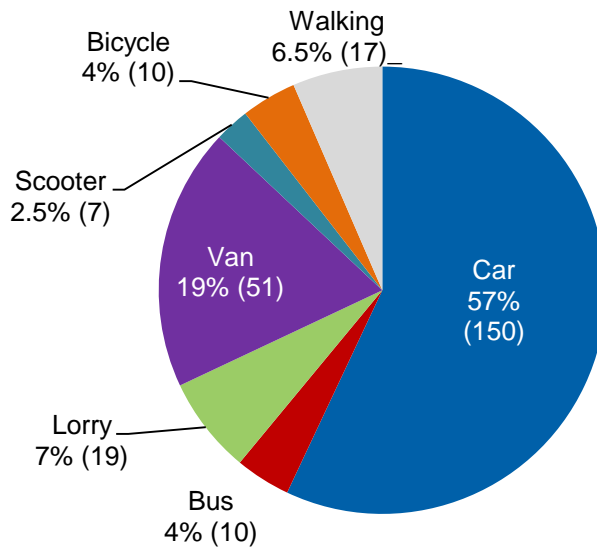


Figure 18: Traffic survey recorded on 25th April between 10:10 and 10:20 AM

Most pupils are already walking to school, as can be seen in Figure 19, corresponding to 90% of 32 surveyed parents preferring and choosing to walk, most of whom live less than one mile away from the school. Walking is regarded as the most convenient way to get to school in terms of time and feasibility, and is also considered good exercise by many parents. Some also highlighted the difficulties with parking and traffic in the area as a reason for not going by car.

Although these results are encouraging with regards to sustainable travel to school, many pupils still wish to use their bikes to commute. Despite the fact that 70% of parents (from 32 who were surveyed) have bikes and some of them bike to work, the consensus amongst parents was that it is too dangerous to take children to school by bike without more appropriate facilities and/or regulations.

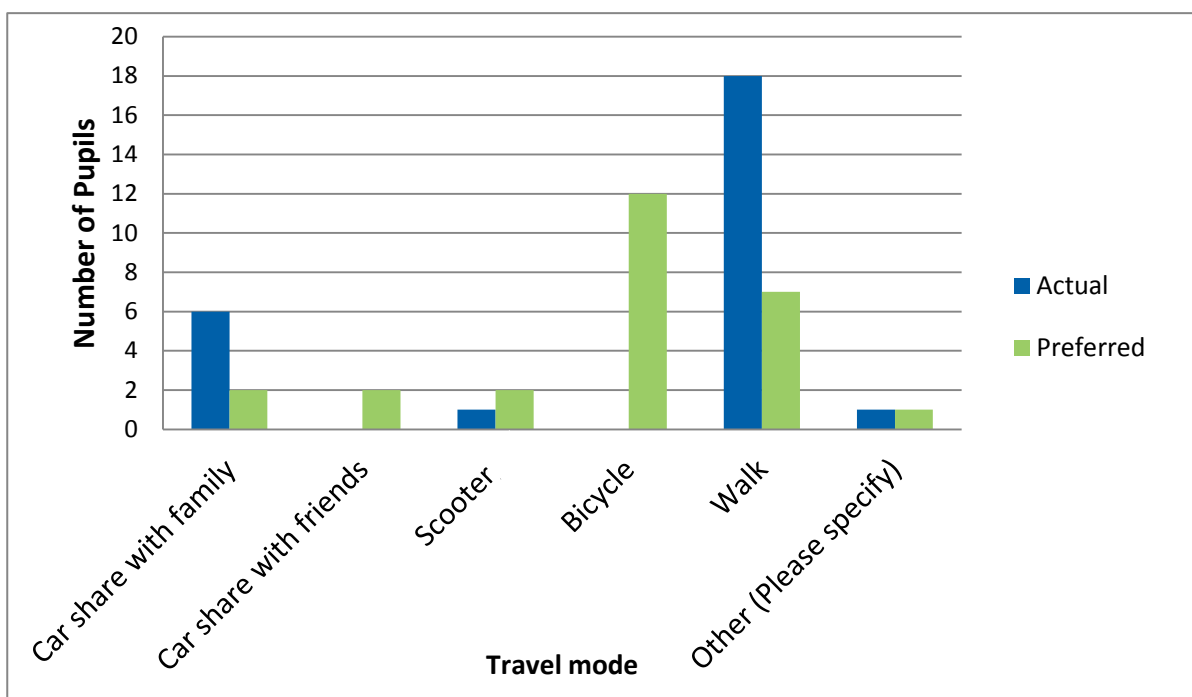


Figure 19: Pupils' actual vs preferred method of travelling to school (26 respondents)

Both parents and pupils see safety as the most important and, for parents, most concerning factor when travelling. It is interesting that pupils pointed to pollution and time twice as frequently as parents as main worries on their journey with only 15% (from 32 surveyed) choosing 'danger' as a concerning factor.

2.2.3. Conclusions and Recommendations

East Sheen Primary School is located on Upper Richmond Road, with all entrances located facing the road, acting as a through-route for many trucks and other traffic. This makes it very difficult for the school to manage the high levels of pollution that children are exposed to on their way to school, as well as when they are in the playground. However, there are some actions which could mitigate the effects.

School site and immediate area recommendations

- More greenery should be installed along the fence separating the school playground from Upper Richmond Road as this would act as a useful barrier and reduce the diffusion of airborne pollutants from the road into the school area. By far the largest source of pollution is clearly the main road and so any mitigation measures should focus on this side of the school.
- The research should be revisited periodically to map any changes and to ensure that any mitigation measures are having the desired effect. Queen's Primary School could operate its own on-site diffusion tubes as these are low cost and simple to replace on a monthly basis. The use of a small number of tubes around the school site would ease the concerns of many parents regarding air quality and could also be incorporated into the science curriculum to allow children to engage further with the subject.

Travel Plan and Behavioural Recommendations

- As noted above in the Travel Plan Analysis there are already many commendable activities around promoting safety, sustainable travel models, and partnerships delivering training sessions. This increases all parties' awareness and enthusiasm to work jointly on improving Air Quality and safety in the main area of concern which is Upper Richmond Road. The school should continue all these activities and put them in the agenda for the following year, with particular emphasis on maintaining cooperation with parents and local authorities to influence future road and safety improvements.
- Despite efforts to engage parents and the wider community, only a few became involved, although in East Sheen Primary School a 'Green Team' was initiated by the parents. Continued effort is needed to build on initial work in this area.

- The school travel plan should be updated and publicised to reflect air pollution data and engage with pupils to ensure they understand and embrace this change. The specifics of the findings are as follows:
 - If approaching from South of the school one should emerge onto the South Circular from Hertford Avenue if possible, i.e. as near to the school as is practicable. The South Circular experiences significantly higher pollution levels than other roads in the area and so time spent on this road should be minimised.
 - If approaching the school from the North / North-West one should join the South Circular from Queen's Road (the nearest side-street which emerges opposite the school). Time spent on the South Circular should be avoided and so the most appropriate route through the network of side streets should be taken.
 - These recommendations are valid whether walking or cycling, although this project has shown that cycling is seen as the more dangerous option, and so walking appears to be preferable.

2.3. Darell Primary School

2.3.1. Background and Context



Darell Primary School is a two-form entry school located in the London Borough of Richmond upon Thames. The main entrance and the entrance to the nursery are located on residential streets running perpendicular to the South Circular. However, the school's proximity to the main road, and a particularly busy roundabout, are of concern (as can be seen to the West in Figure 20). Research and engagement found that parents often park in Sainsbury's car park and walk with their children across the

Figure 20: Google Maps displaying typical traffic - Monday 15.30 August 2017

dual carriageway. The area directly surrounding the school is residential, but the South Circular has high levels of pollution according to the modelling data seen in Figure 22 on the following page. There are two playgrounds located at either end of the school building, although neither of these is directly adjacent to the South Circular. The area immediately surrounding the school has a lot of green infrastructure.

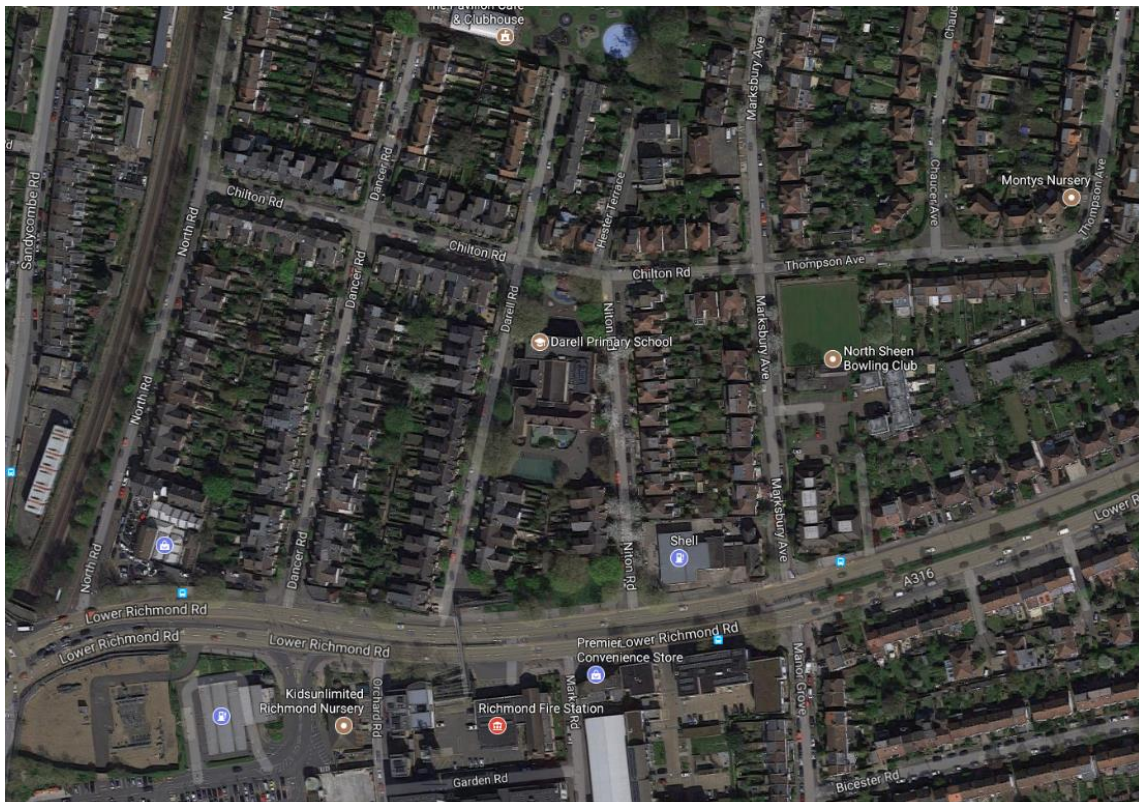


Figure 21: An aerial view of Darell Primary School

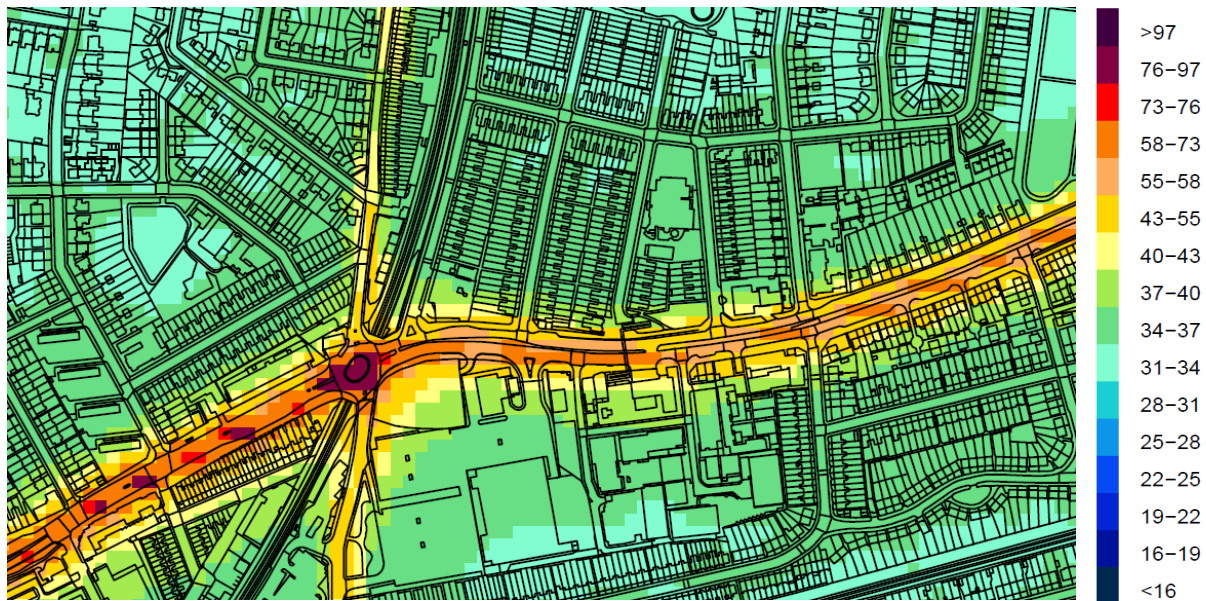


Figure 22: Map showing modelled NO₂ pollution concentrations for 2013 for Darell Primary School
Modelling carried out by ERG, King's College London.

2.3.2. Activities and Results

NO₂ Measurements

The approach taken with Darell Primary School was different than that of others; given local knowledge and insight, the audit was adapted to provide a comparison of two scenarios. In scenario 1, which is currently widely adopted, many parents drive to school, parking their cars in Sainsbury's car park and using the footbridge to cross the A316. An alternative route was devised, which takes advantage of the unrestricted parking on North road to suggest that, if parents were to use the 'park and stride' method of getting to school there may be a health benefit in reconsidering the parking location. It also provides air pollution levels in the area which can be considered when walking to school.

Figure 23 on the following page shows the NO₂ results collected along the two routes, clearly demonstrating the higher level of air pollution along the A316. The tube placed along the main road registered 32.35 $\mu\text{g}/\text{m}^3$. Although this is higher than other diffusion tube sites in the area, it is still below EU set limits, and this is likely due to the reduced school traffic at this time. Additionally, it may be impacted by the width of the road and free-flowing air along the A316.

Route 2 clearly came out as the preferable option, with the highest level of NO₂ registered by a diffusion tube being 16.21 $\mu\text{g}/\text{m}^3$, as compared with Route 1 which produced no value below 20 $\mu\text{g}/\text{m}^3$. Although there is a footbridge which is used to cross the A316, Route 2 is the safer and more pleasant option, with the route going through a recreation ground and quiet residential streets, as opposed to parking in a supermarket carpark to then cross a dual carriageway with a central reservation.

Unfortunately, the diffusion tube coloured grey in Figure 23 represents missing data, which was either stolen or knocked down. This diffusion tube was placed in North Sheen Recreation Ground and so would likely have returned an equally low result as the surrounding area.

Nitrogen Dioxide (NO₂) monthly average:

- GREEN = < 30 µg/m³
- ORANGE = 30 - 40 µg/m³
- RED = > 40 µg/m³

EU Legal Limits:
40 µg/m³ (over 1 yr)
50 µg/m³ (over 24h)

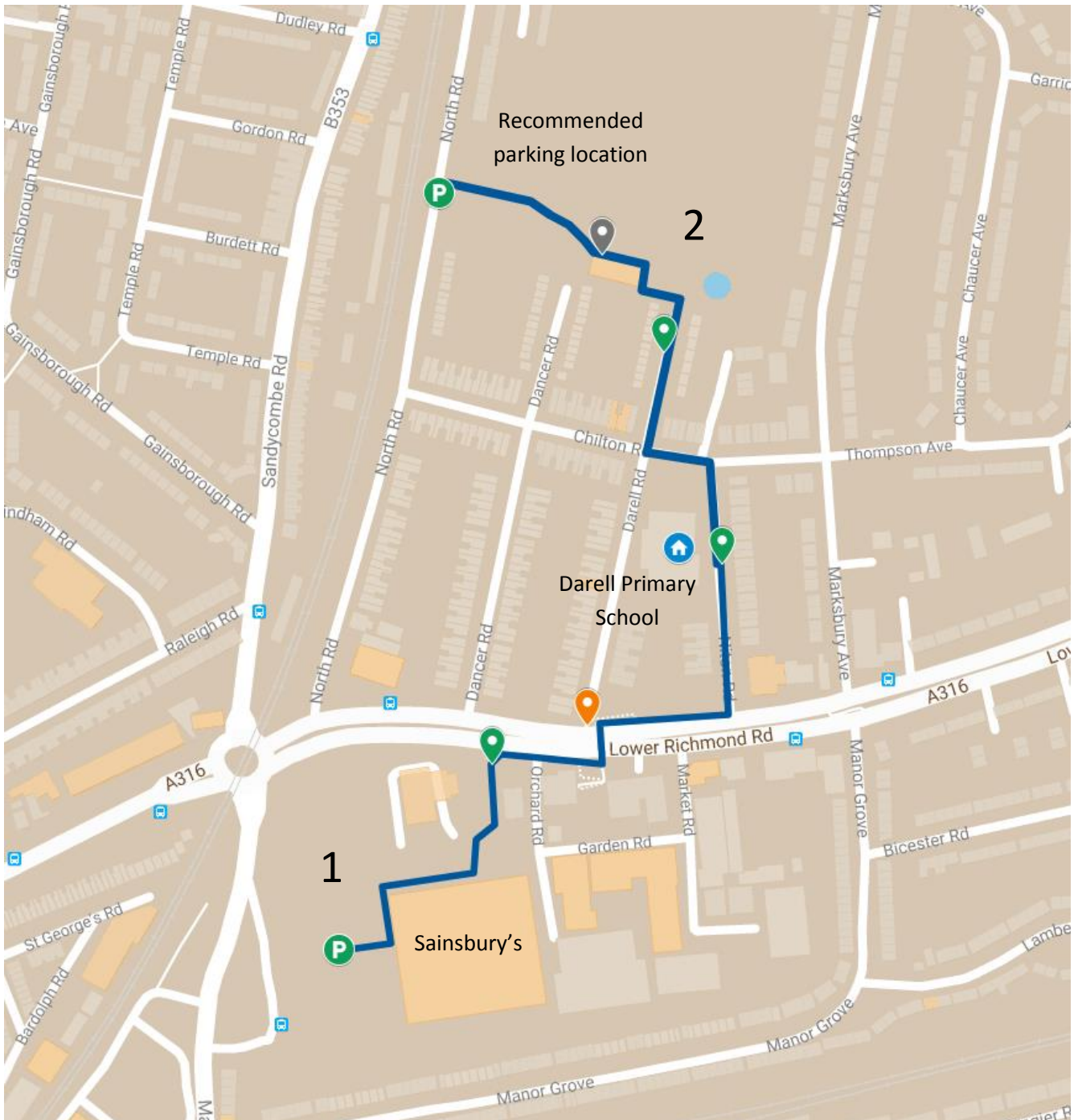


Figure 23: A map showing NO₂ results for Darell Primary School



Figure 24: A map showing on-site NO₂ results for Darell Primary School

As can be seen above in Figure 24 above, all readings taken on-site at Darell Primary School registered well below EU limits, with the highest value being 28.76 µg/m³. This reading was given at the site located nearest the South Circular and a petrol station, and so would be expected to have the highest levels of NO₂. The conclusion that can be drawn from these results is that the immediate school-site does not exhibit any high readings of nitrogen dioxides. Therefore, the recommendations would do better to focus on children’s routes to the school, with the South Circular having far higher levels of air pollution.

Particulate Matter Measurements

Unfortunately, technical issues with the equipment prevented particulate matter measurements from being gathered along walking routes to/from this school. This research will be repeated in the near future, with the objective of regularly monitoring schools which are deemed to be at risk of high pollution levels. Particulate measurements were taken inside the school grounds, all of which presented low levels and can be viewed in the appendices.

Travel Plan Analysis

Darell Primary School has a School Travel Plan in place, and was awarded silver level by TfL's STARS in September 2016. Analysis of the travel plan shows the following:

Good practices the school has adopted

- Anti-idling campaign, poster competition to encourage parents not to park on the yellow zigzag lines and not idle. Poster competition was launched to try and have more impact with parents than the regular reminders in the school newsletter (see Figure 22)
- Anna Gilbert (school governor): "We have seen some encouraging shifts in the travel survey results over the past three years, with more pupils walking (up 4%) /cycling (up 3%) to school and fewer pupils being driven to school (down 5%)".



Figure 25: Banner outside Darell Primary School, showing pupils' posters

Issues outlined

The school site is surrounded by residential streets with little or no off-street parking, hence local residents parking spaces are under pressure. Families walking to school find it difficult to cross Chilton Road and Niton Road due to drivers parking right up to the corners. Pedestrian crossings on the A316 are also dangerous as cars drive too fast (30mph speed limit not well signposted), zebra crossings too close to roundabout, and the pedestrian footbridge is not in good condition although the school actively encourages families to use the bridge as this remains the safest way to cross the A316.

Key findings

- High levels of traffic and pollution along the A316 (Lower Richmond Road) compared to much less polluted air on residential streets surrounding the school
- The majority of pupils (88% - 24 of 27 surveyed) showed a preference for sustainable means of travel, i.e. walking, cycling, and by scooter
- When the pupils were asked what the biggest motivation for their mode of travel to school they cited 'safety'
- Darell Primary School has a wider catchment area than Queen's and East Sheen, so there are greater numbers of pupils being driven to school.

- Darrell Primary School Travel Plan is extensive, and already includes suggestions for alternative places to ‘Park and Stride’ for parents. The challenge is to keep promoting this and making sure that this advice is adhered to. The new maps with routes to school could provide further evidence to convince parents to do so.

Travel preferences and behaviour

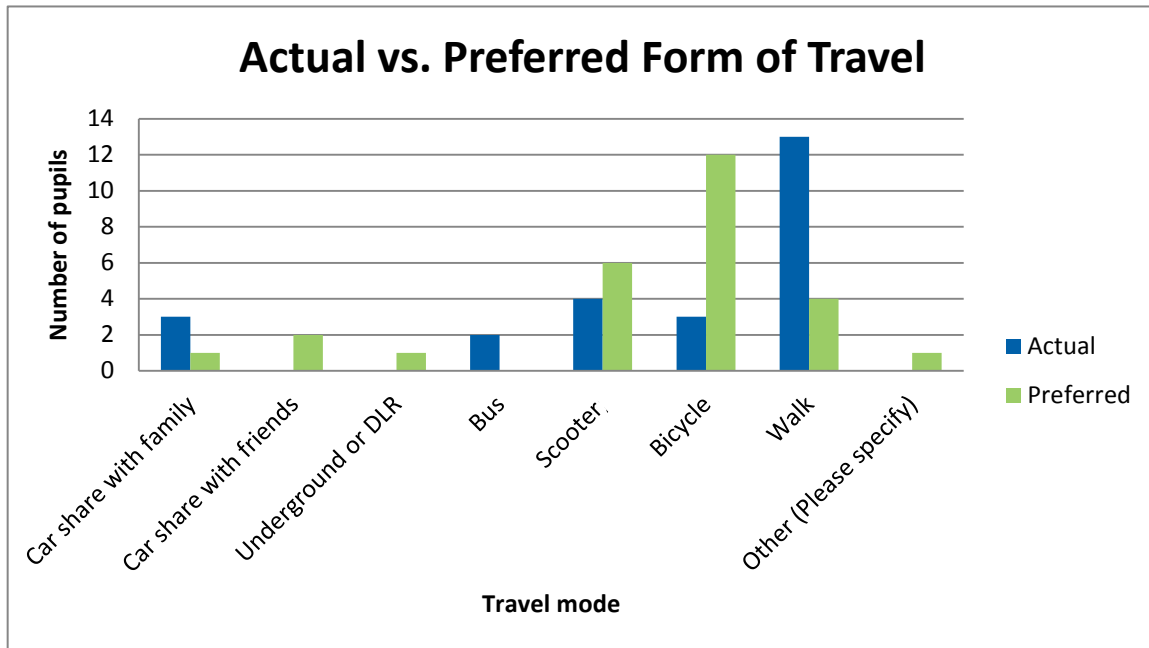


Figure 26: Pupils' actual vs preferred method of travelling to school

Figure 26 shows the comparison between actual and preferred forms of travel to school indicated by Darrell pupils during their second Cleaner Air 4 Schools lesson in June 2017. As in the case of East Sheen Primary and Queen’s School, most children from the majority who already walk to school would prefer to travel by bike or scooter. Only three children would prefer to be taken by car, which can be linked to one of the major concerns when travelling, as pointed out by one third of pupils, which is having a ‘boring’ journey. One quarter of children stated the importance of socialising and exercise during their journey to school and it is clear that sustainable means of travel are the most desired ones and regarded as a valuable and interesting time.

When the pupils were asked the biggest motivation for their mode of travel to school 64% (17 of 27 surveyed) cited ‘safety’. When asked what their biggest concern was when traveling the primary concern apart from ‘boredom’ was ‘pollution’ and ‘time’ at the same rate. Although many are concerned about pollution it is not taken into consideration in actual travel motivations. However it is difficult to evaluate how their concerns influence real travel decision, as parents are the ones who have the final say.

2.3.3. Conclusions and Recommendations

Information on work which has been carried out by Darell Primary School can be found on [Richmond Council's website here](#), including improving of footways to aid pedestrian crossing near the school.

Darell Primary School is located in a residential area with fairly low levels of air pollution. The main challenges identified included car congestion around the school gates during pick-up and drop-off times, and the high levels of pollution some children may have to encounter walking along or across the A316.

School site and immediate area recommendations

- The network of roads immediately surrounding Darell Primary School (including Darell Road, Niton Road, and Chilton Road) experience higher levels of traffic during school start and finish times, with many parents attempting to pull over as near to the school as possible, often leaving their engines running in the process. More engagement should be conducted with pupils' parents to make them aware of the adverse health effects of vehicle emissions and encouraging them to consider how their decisions will impact their own children.
- These air quality measurements should be revisited periodically to track any changes in factors such as traffic flow and to monitor if this impacts air pollution locally. Darell's low on-site NO₂ results would imply there is little need for permanent tubes within the school site.

Travel Plan and Behavioural Recommendations

- Staff at the school should continue walking, cycling and Road Safety initiatives.
- Increase the amount of cycling racks and make "pooling" facilities available. Additionally the school could consider introducing a staff shower to make arriving in school after cycling a more comfortable option.
- The school travel plan should be updated and publicised to reflect air pollution data and engage with pupils to ensure they understand and embrace this change. The specifics of the findings are as follows:
 - A large number of parents choose to park and stride. For those for whom that remains the best option, there should be a recommendation to park in North Road, next to North Sheen Recreation Ground, as opposed to Sainsbury's car park. This area of North Road has parking restrictions only between 10am – Noon and so there is ample space and opportunity for it to be used during the school run.
 - The A316 (South Circular) should be avoided as much as possible due to its significantly higher levels of air pollution.

3. Conclusion

This Schools Audit Project was a great success and fulfilled its aims of profiling each school and creating bespoke recommendations to improve the air quality challenge faced by the school pupils. In addition to this, the engagement work carried out with the pupils greatly expanded their knowledge and awareness of air quality issues and how it impacts their everyday lives. Children have developing lungs and are closer to pollution sources, making them particularly vulnerable to the effects of poor air quality. Each school site presented unique challenges and opportunities, therefore the inclusion and engagement of parents, teachers, and pupils was crucial; their local knowledge led to insights which the data alone did not necessarily uncover.

These audits are not intended to give an overall or long-term picture of air quality surrounding the schools, but are instead designed to provide practical conclusions and recommendations which can be implemented by the local authority, the schools, the parents, and the pupils themselves. The data gathered only represents a single month's readings and so, although this can be viewed in a wider context, it cannot be used to give an accurate annual picture of air quality. It is for this reason we hope this project, along with others such as the Mayor of London's school audits⁷, will be continued. In some schools it would be appropriate to carry out continuous on-site monitoring, while in others this is clearly not necessary and so resources can be targeted elsewhere.

A number of valuable insights have emerged from this project, which add to our existing knowledge and encourage people to consider air quality when making everyday decisions, particularly when on the school run. There are wider benefits of healthy and active travel which can be effective in order to encourage a change in the prevailing 'driving as convenience' mentality, and walking buses have the potential to replace the car as a convenient form of transport if operated effectively. For those who need to travel by car, there are other recommendations which can be made, including appropriate park and stride routes, and ensuring they do not idle their engines and endanger their children's health.

The health and wellbeing of children is of the utmost importance to the local authority, and we will do everything within our power to ensure that necessary actions are taken and recommendations are made to reduce the levels of air pollution in the borough and increase the awareness and engagement from members of the public.

This report and the work underpinning it could not have been achieved without contributions from the London Sustainability Exchange for undertaking the engagement with the children; the schools for their cooperation and support; the parents and community for their interest and assistance; and Professor Roger Mason for his insights into air quality and the local area, and his help with monitoring.

⁷ <https://www.london.gov.uk/press-releases/mayoral/mayors-air-quality-audits-to-protect-london-kids>

4. Appendices

4.1. Raw Data

Queen's Primary School						
NO2 Data						
Group	Location	Lat	Lon	Date from	Date to	NO2 ug/m3
Queen's School	Bike shed Queens School	51.481125	-0.285492	13/03/2017	31/03/2017	29.01
Queen's School	Gap in fence Queens School	51.48156	-0.285356	13/03/2017	31/03/2017	43.37
Queen's School	(Year 1 and 2)	51.481335	-0.286092	13/03/2017	31/03/2017	27.43
Queen's School	Reception playground (in the corner on a tree)	51.481061	-0.286371	13/03/2017	31/03/2017	24.92
Queen's School	Y2 class room	51.481402	-0.285476	13/03/2017	31/03/2017	17.09
Queen's School	Year 6	51.481395	-0.28546	13/03/2017	31/03/2017	28.24
Queen's School	Staff gate	51.480847	-0.285067	13/03/2017	31/03/2017	27.31
Queen's School	Cumberland	51.481152	-0.284444	13/03/2017	31/03/2017	34.81
Queen's School	Eco are	51.480715	-0.286002	13/03/2017	31/03/2017	25.96
Lower calibration	Melbourne	-37.8136	144.9631	05/06/2017	05/06/2017	0
Upper calibration	Melbourne	-37.8136	144.9631	05/06/2017	05/06/2017	100

		Exposure Data					TOTAL	
Location	Sample Number	Date On	Date Off	Time (hr.)	mg/m ³ *	ppb *	µg NO ₂	
84 Mortlake Road	946548	18/07/2017	18/08/2017	746.88	23.41	12.22	1.27	
Opposite 2 West Park Road	946549	18/07/2017	18/08/2017	746.83	16.97	8.86	0.92	
Centre of Kew Plaza	946550	18/07/2017	18/08/2017	746.72	14.74	7.69	0.80	
Junction between Leybourne Park/Kew Gardens Road	946551	18/07/2017	18/08/2017	746.85	20.97	10.94	1.14	
Queen's School outside Staff car park	946552	18/07/2017	18/08/2017	746.53	15.85	8.27	0.86	
opposite junction between Kent Road and Mortlake Road	946553	18/07/2017	18/08/2017	746.47	35.56	18.56	1.93	
Outside Dexters - junction Kew Road/S.Circular	946554	18/07/2017	18/08/2017	746.83	45.69	23.85	2.48	
Opposite 68 Kew Green Corner with pond	946555	18/07/2017	18/08/2017	746.78	17.58	9.17	0.95	
Tree outside 22 Bushwood Road	946556	18/07/2017	18/08/2017	746.00	15.97	8.34	0.87	
Bend in Forest Road	946557	18/07/2017	18/08/2017	745.82	15.26	7.96	0.83	
Outside 41 Mortlake Road	946558	18/07/2017	18/08/2017	745.77	40.05	20.90	2.17	
Opposite 371 on the B353	946559	18/07/2017	18/08/2017	746.02	28.37	14.80	1.54	
Outside 48 The Avenue	946560	18/07/2017	18/08/2017	745.93	16.34	8.53	0.89	
Outside Thornycroft Road Junction The Avenue/Kew Road	946561	18/07/2017	18/08/2017	745.87	25.59	13.35	1.39	
Outside 240 Kew Road (Unicorn School)	946562	18/07/2017	18/08/2017	745.78	33.15	17.30	1.80	
Outside Studio Montessori Nursery	946563	18/07/2017	18/08/2017	745.65	22.24	11.60	1.21	
Next to railway bridge on Mortlake Road	946564	18/07/2017	18/08/2017	744.98	43.01	22.45	2.33	

Particulate Matter Data

Location	Date	PM2.5 mg/m ³	PM10 mg/m ³
Mortlake Road / West Park Road	03/07/2017	6.5	17
Mortlake Road opposite West Park Ave.	03/07/2017	6.3	17.1
Mortlake Road / Burlington Ave.	03/07/2017	5.7	14.2
Mortlake Road next to Railway Bridge	03/07/2017	6.5	17.3
Mortlake Road / Cumberland Road	03/07/2017	5.2	12.9
Cumberland Road outside school	03/07/2017	6.8	14.9
Cumberland Road / Kew Gardens Road	03/07/2017	6.8	16.5
Sandycombe Road / Leybourne Park	03/07/2017	6.3	16
Kew Gardens station underpass	03/07/2017	7.3	20.6
West Park Road / Burlington Ave.	03/07/2017	7	17.8
Cumberland Road outside school	04/07/2017	6.8	14.9
Mortlake Road next to gap in school fence	04/07/2017	6	14.4
Kew Road / Mortlake Road (outside Dexter's estate agents)	04/07/2017	6.4	11.4
Kew Green / Bushwood Road	04/07/2017	4.8	12.1
Buswood Road (outside No.21)	04/07/2017	4.8	11.1

Bushwood Road / Maze Road	04/07/2017	4.5	9.4
Maze Road / Forest Road	04/07/2017	4.6	10.6
Mortlake Road / Forest Road	04/07/2017	5.7	14
Kew Road / The Avenue	05/07/2017	3.7	9.1
Kew Road (outside Unicorn School)	05/07/2017	3.9	14.9
Kew Road / Broomfield Road	05/07/2017	4.4	10
Kew Gardens Road (outside nursery)	05/07/2017	3.3	9.6
Cumberland Road (outside school)	05/07/2017	3.9	10.8
Sandycombe Road / Leyborne Park	05/07/2017	3.9	15.8
Sandycombe Road / Ennerdale Road	05/07/2017	4	10.9
Ennerdale Road / Holmesdale Road	05/07/2017	3.7	10.8
Ennerdale Road / The Avenue	05/07/2017	3.7	8.7
Location	Date	PM2.5 mg/m³	PM10 mg/m³
Centre of 3G sports pitch	13/07/2017	2.8	9.4
Centre of playground between school building and grass	13/07/2017	2.9	12.1
Centre of playground between school building and fence facing Mortlake Road	13/07/2017	3.6	13.8
First floor classroom (nearest Mortlake Road)	13/07/2017	1.8	12
First floor classroom (furthest from Mortlake Road)	13/07/2017	2.4	6.5

East Sheen Primary School						
NO2 Data						
Group	Location	Lat	Lon	Date from	Date to	NO2 ug/m3
East Sheen Primary School	Middle front gate	51.46518	-0.255676	21/03/2017	18/04/2017	39.65
East Sheen Primary School	Back playground	51.464808	-0.254673	21/03/2017	18/04/2017	22.60
East Sheen Primary School	Back fence near Community garden	51.464575	-0.254648	21/03/2017	18/04/2017	22.15
East Sheen Primary School	Front gate	51.465132	-0.256209	21/03/2017	18/04/2017	34.70
East Sheen Primary School	Outside front classroom yellow pole	51.464997	-0.255841	21/03/2017	18/04/2017	24.90
East Sheen Primary School	Inside reception building	51.46458	-0.255929	21/03/2017	18/04/2017	14.76
East Sheen Primary School	Outside entrance building yellow pole	51.464946	-0.255229	21/03/2017	18/04/2017	24.52
East Sheen Primary School	Third outside gate facing road	51.465069	-0.255361	21/03/2017	18/04/2017	32.09
East Sheen Primary School	4th outside gate closest to roa	51.465128	-0.255146	21/03/2017	18/04/2017	42.47
East Sheen Primary School	94A Putney	51.463429	-0.215871	21/03/2017	18/04/2017	71.62

	High Street						
Lower calibration	Melbourne	-37.8136	144.9631	05/06/2017	05/06/2017	0	
Upper calibration	Melbourne	-37.8136	144.9631	05/06/2017	05/06/2017	100	
		Exposure Data					TOTAL
Location	Sample Number	Date On	Date Off	Time (hr.)	mg/m³ *	ppb *	µg NO₂
Opposite 18 Vicarage Road	946572	18/07/2017	18/08/2017	744.42	13.55	7.07	0.73
Outside 56 Palewell Road	946573	18/07/2017	18/08/2017	744.25	11.78	6.15	0.64
Outside Sheen Tyres Palewell Park/S.Circular	946574	18/07/2017	18/08/2017	744.13	28.73	15.00	1.55
Junction Vernon Road/Glendower Road	946575	18/07/2017	18/08/2017	744.50	14.10	7.36	0.76
Outside 55 South Warple Way	946576	18/07/2017	18/08/2017	744.35	15.19	7.93	0.82
Junction Queen's Road/South Warple Way	946577	18/07/2017	18/08/2017	744.22	15.68	8.18	0.85
Outside 49 Queens Road	946578	18/07/2017	18/08/2017	744.12	14.31	7.47	0.77
Junction Queens Road/S.Circular	946579	18/07/2017	18/08/2017	744.00	28.29	14.77	1.53
Eastern Crossing outside East Sheen	946580	18/07/2017	18/08/2017	743.78	34.65	18.08	1.87
Richmond Park Academy opposite recycling bins	946581	18/07/2017	18/08/2017	743.62	12.23	6.38	0.66
Junction Hertford Ave/Park Drive	946582	18/07/2017	18/08/2017	743.42	12.42	6.48	0.67
Particulate Matter Data							
Location	Date	PM2.5 mg/m³	PM10 mg/m³				
Vicaraga Road / Palewell Park	07/07/2017	4.4	17.5				
Palewell Park	07/07/2017	3.1	10.9				

Palewell Park / Park Ave.	07/07/2017	3	9.8
Palewell Park / South Circular	07/07/2017	3.9	10.2
South Circular / Wallarton Gardens	07/07/2017	4.5	15.9
Heartford Ave. / South Circular	07/07/2017	3.6	10
South Circular (near western entrance to East Sheen Primary School)	07/07/2017	12.2	24.2
Hertford Ave. (outside academy)	07/07/2017	4	11.1
Hertford Ave. / Park Drive	07/07/2017	3.8	10.2
Glendower Road / Glendower Gardens	10/07/2017	5.4	11.9
South Worple Way / Treherne Road	10/07/2017	5.2	14
South Worple Way / Queen's Road	10/07/2017	5.2	12.8
Queen's Road (where road bends)	10/07/2017	5.2	11.3
Queen's Road / South Circular	10/07/2017	5.1	13
South Circular (near western entrance to East Sheen Primary School)	10/07/2017	5.4	18.5
South Circular / Gilpin Ave.	10/07/2017	6	16.7
South Circular / Portman Ave.	10/07/2017	6.4	18.8
Portman Ave.	10/07/2017	4.7	10.8

Location	Date	PM2.5 mg/m ³	PM10 mg/m ³
Inside Playground - near Western gate	10/07/2017	3.6	8.6
Centre of playground - Western side	10/07/2017	3.3	8.6
Classroom at rear of building	10/07/2017	4.6*	66.2*
Rear sports pitch	10/07/2017	3.5	8.9
Classroom at rear of building facing sports pitch	10/07/2017	3.6**	25.6**
Centre of playground - Eastern side	10/07/2017	3.9	9.7
Eastern Playground, nearest front gate	10/07/2017	4	9.3

* Classroom was full of children at time of reading

** Classroom was full of children very shortly before reading

Darell Primary School

NO2 Data

Group	Location	Lat	Lon	Date from	Date to	NO2 ug/m3
Darell Primary School	71 Castlenau	51.480189	-0.237335	30/03/2017	20/04/2017	36.63
Darell Primary School	Facing Chilton Road	51.469245	-0.284407	30/03/2017	20/04/2017	27.06
Darell Primary School	Next to wall inside playground	51.469009	-0.284533	30/03/2017	20/04/2017	25.22

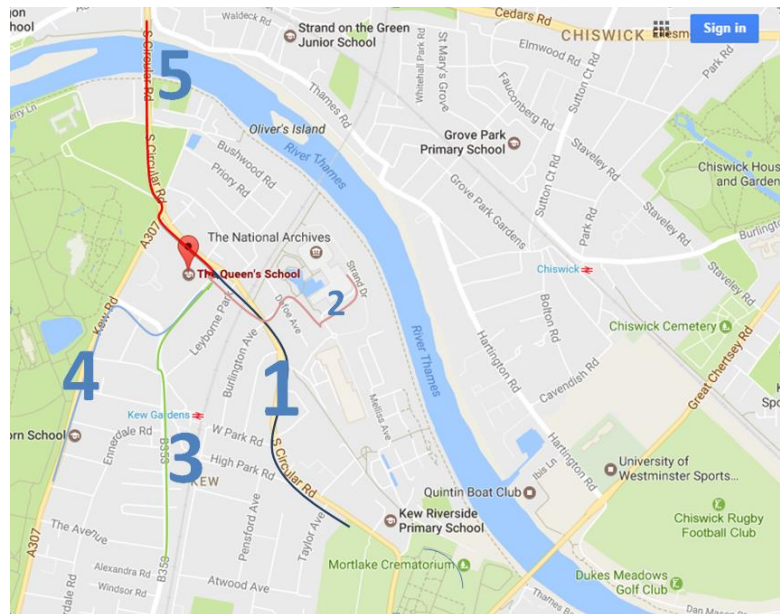
Darell Primary School	Darell Rd entrance, bike stand	51.468992	-0.284833	30/03/2017	20/04/2017	26.64		
Darell Primary School	Main reception entrance	51.468815	-0.2843	30/03/2017	20/04/2017	25.88		
Darell Primary School	Junior playground center	51.468494	-0.234569	30/03/2017	20/04/2017	25.92		
Darell Primary School	Next to Darell Rd entrance	51.468598	-0.284972	30/03/2017	20/04/2017	22.09		
Darell Primary School	Inside reception class (rainbow)	51.468649	-0.284471	30/03/2017	20/04/2017	18.04		
Darell Primary School	Upstairs inside classroom	51.468649	-0.284471	30/03/2017	20/04/2017	14.69		
Darell Primary School	Pavement, light pole	51.468474	-0.284194	30/03/2017	20/04/2017	28.76		
Lower calibration	Melbourne	-37.8136	144.9631	05/06/2017	05/06/2017	0		
Upper calibration	Melbourne	-37.8136	144.9631	05/06/2017	05/06/2017	100		
		Exposure Data					TOTAL	
Location	Sample Number	Date On	Date Off	Time (hr.)	mg/m³ *	ppb *	µg NO₂	
Lampost centre of Sainsburys car park	946565	18/07/2017	18/08/2017	744.97	21.59	11.27	1.17	
Entrance Gate of Sainsburys Car Park	946566	18/07/2017	18/08/2017	744.82	22.59	11.79	1.22	
Lampost below footbridge (Darell-side)	946567	18/07/2017	18/08/2017	744.67	32.35	16.89	1.75	

Lampost opposite Darrel entrance	946568	18/07/2017	18/08/2017	744.42	16.21	8.46	0.88	
Outside 55 Darrell Road	946569	18/07/2017	18/08/2017	744.35	15.56	8.12	0.84	
Lampost outside North Sheen Rec/North Road	946571	18/07/2017	18/08/2017	744.12	15.96	8.33	0.86	

4.2. Survey results

These routes to school were chosen by pupils and then rated

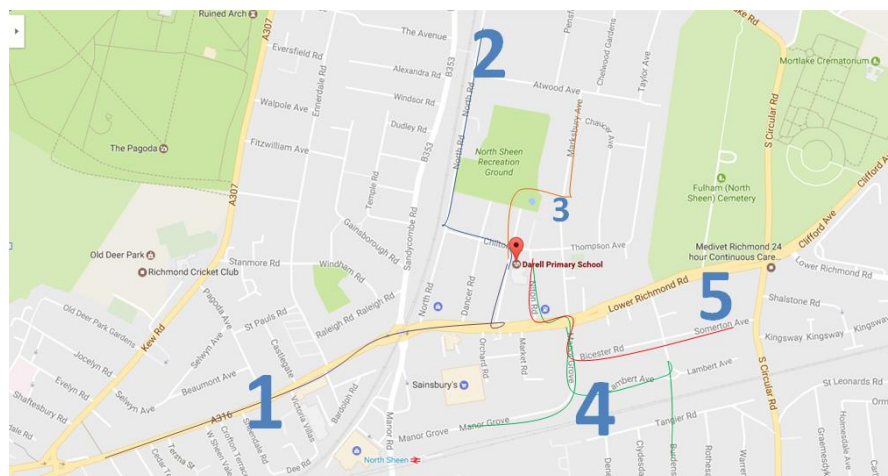
Queen's Primary School



East Sheen Primary School



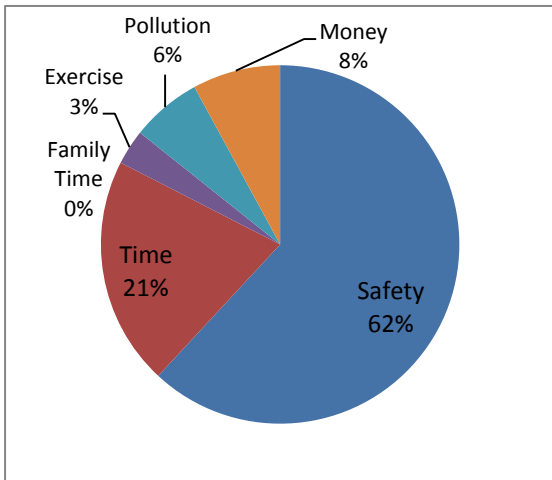
Darell Primary School



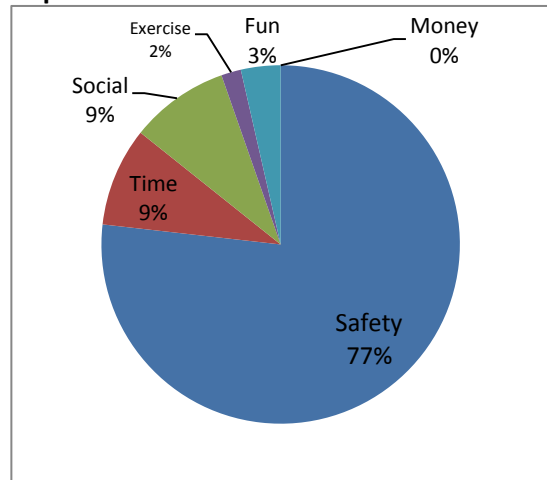
Queen's CE Primary School

What is most important to you when travelling?

Parents

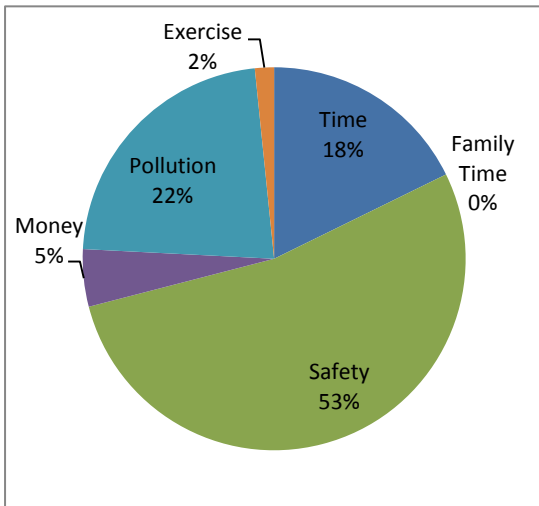


Pupils

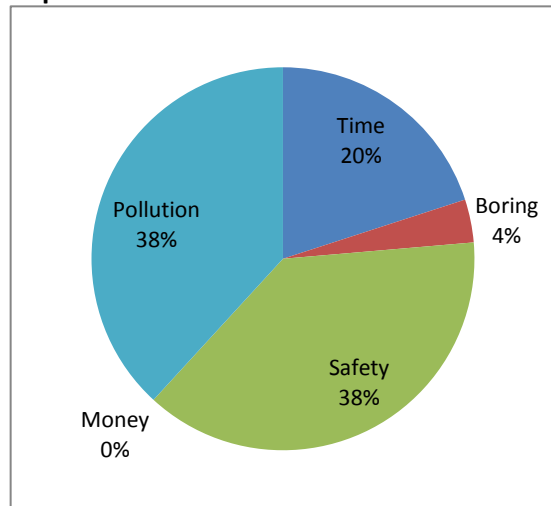


What are you most worried about when travelling to school?

Parents



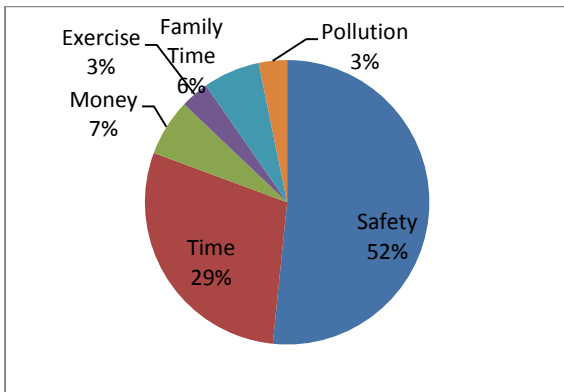
Pupils



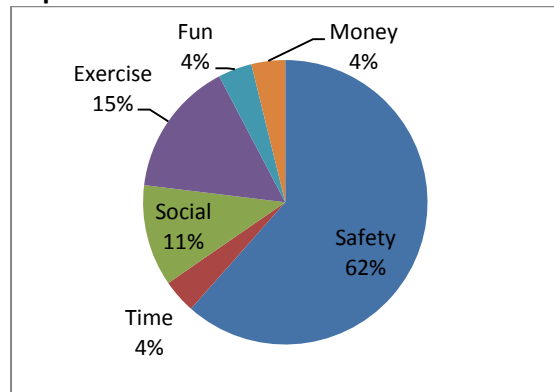
East Sheen Primary School

What is important to you when travelling?

Parents

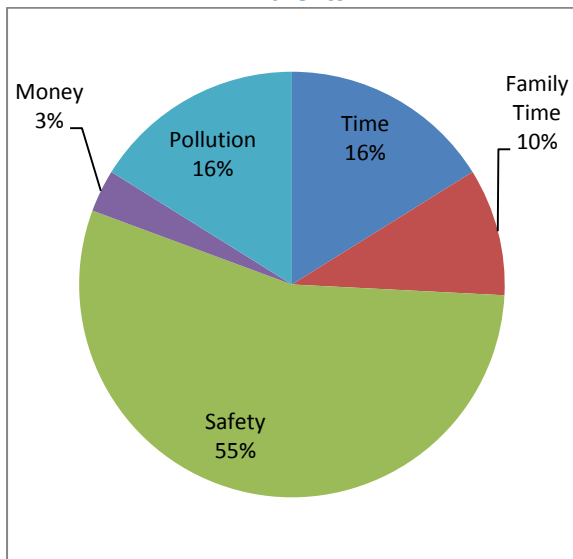


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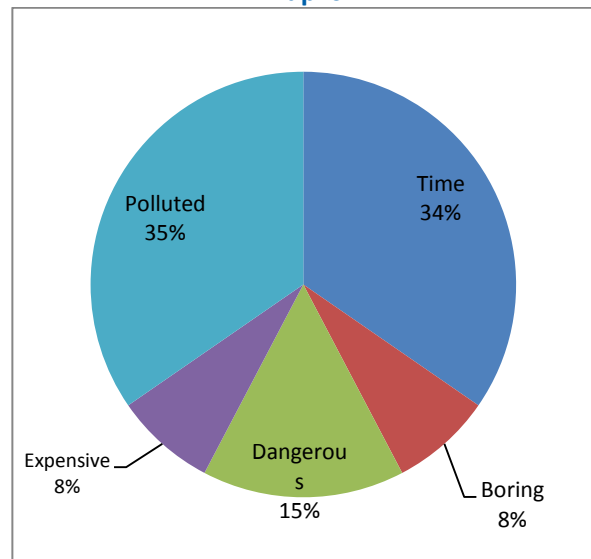


What are you most worried about when travelling to school?

Parents

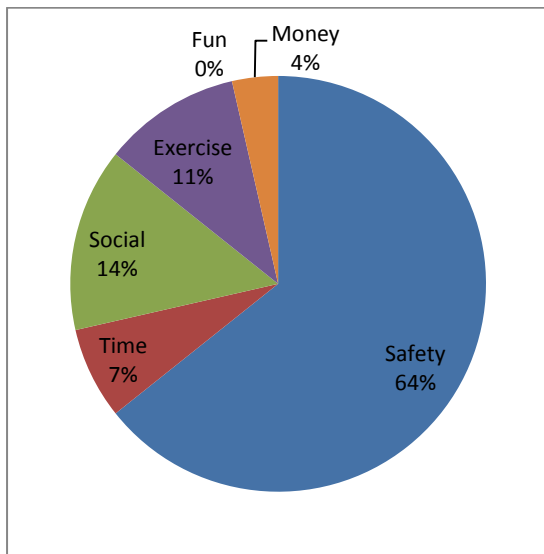


Pupils

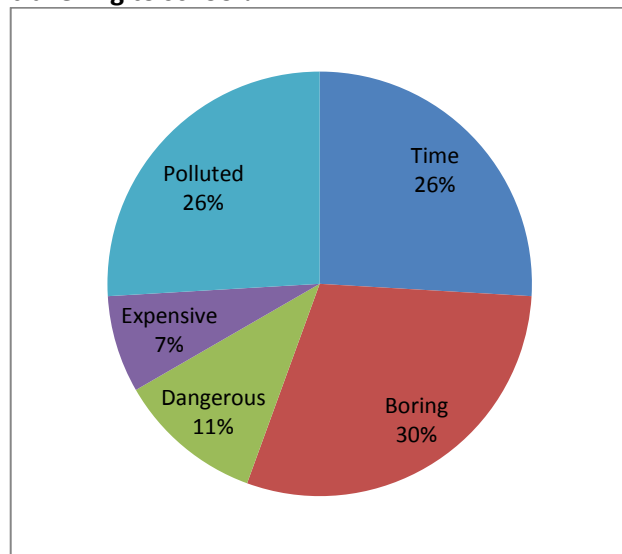


Darell Primary School

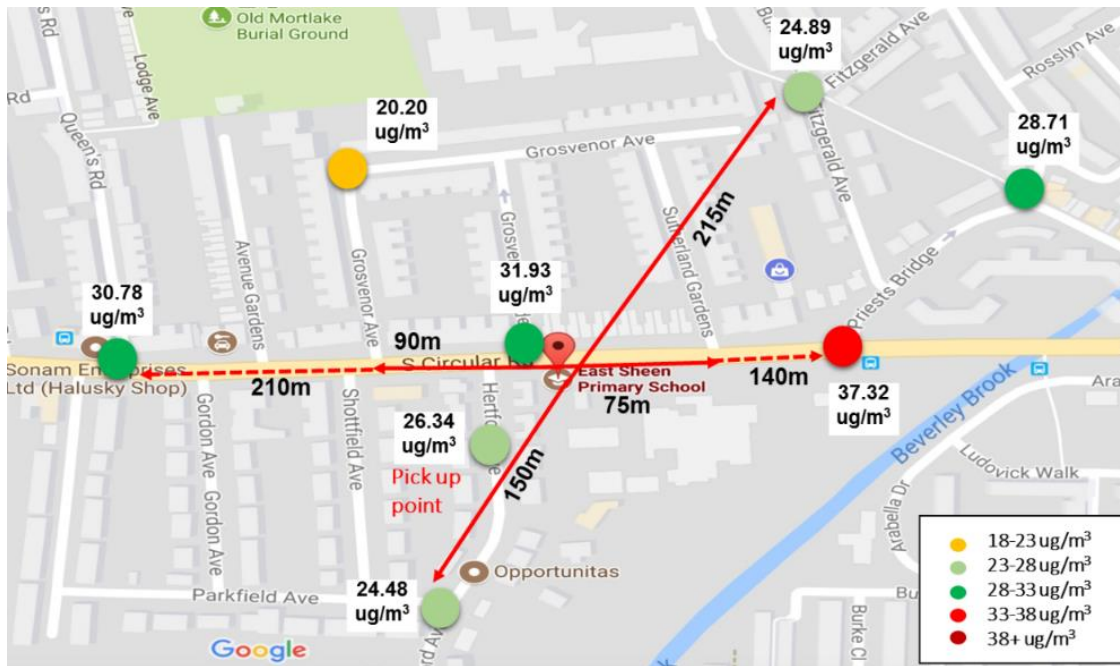
What is important to you when travelling?



What were you most worried about when travelling to school?



4.3. Additional monitoring of NO₂ carried out by UCL student for their dissertation



15/06/17

4.4. Richmond Air Quality Headlines

- The London Borough of Richmond upon Thames is meeting the national Air Quality Standard objectives for all pollutants other than Nitrogen Dioxide (NO₂) and Particulate Matter (PM)
- A recent study by King’s College London for the use of TfL⁸ estimated that 842 people in South West London died prematurely from diseases attributable to long term exposure to fine particulate pollution in 2010, making up almost a quarter of such deaths in London.
- In Richmond upon Thames specifically, PM_{2.5} accounted for 84 deaths in 2010.
- 33.9% of those aged 16-74 in the Borough of Richmond travel to work by car. Richmond upon Thames ranks 15th within London for highest percentage commutes by car⁹.
- Data from the London Atmospheric Emissions Inventory estimates that 13.06% of the total population of Richmond are subject to NO₂ concentrations in excess of the annual mean UK AQ objective of 40µg/m³. (For comparison, Wandsworth is 20.12%, Kingston 7.48%, and Sutton 3.77%).
- NO₂ concentrations remain in excess of the UK Air Quality Objectives at a significant number of locations across the borough. Monitoring during 2016 indicated that the annual mean NO₂ objective of 40µg/m³ was exceeded at 48 of the 64 sites where monitoring was carried out.

⁸Understanding the Health Impacts of Air Pollution 2015

https://www.london.gov.uk/sites/default/files/hiaionlondon_kingsreport_14072015_final.pdf

⁹ 2013 The Car and the Commute, RAC Foundation. http://www.racfoundation.org/assets/rac_foundation/content/downloadables/car-and-the-commute-web-version.pdf