

# Cleaner Air 4 Secondary Schools Toolkit

**LSx**

London Sustainability Exchange

***Aether*** 



**SURREY**

## Acknowledgements

London Sustainability Exchange (LSx) would like to thank Surrey County Council for the funding and support of the Cleaner Air 4 Schools programme.

## About London Sustainability Exchange (LSx)

LSx ([www.lsx.org.uk](http://www.lsx.org.uk)) is a “think and do” charity which creates collaborations that address the complex barriers to sustainability. Our projects provide action-based community development and research to develop, and in turn share, the lessons from our work, and most importantly, influence policies for a sustainable future. LSx aim to:

- Reduce environmental footprint
- Improve the lives of disadvantaged communities
- Improve the health of UK inhabitants
- Improve the knowledge and skills of our communities to achieve these goals

The logo for London Sustainability Exchange (LSx) features the letters 'LSx' in a bold, blue, sans-serif font. The 'x' is stylized with a white diagonal line.

London Sustainability Exchange

## About Surrey County Council

The county of Surrey is located in the South East of England, bordering Kent, East and West Sussex, Hampshire, Berkshire and Greater London. The county is the third most populated in the South East region, with a population of 1.2 million (as of 2015).

The Surrey Council is a local governmental body working within the legal framework set by the central government. Surrey Council's constitution sets out the county's operation and how decisions and procedures are followed and carried out to ensure that decisions and policies are made efficiently, open and accountable to the local people.

The council's code of corporate governance explains how the council will ensure that it meets the objectives of an complies with recognised principles of good governance for its citizens:

- Focusing on the purpose of the authority and on outcomes for the community and creating and implementing a vision for the local area
- Members and officers working together to achieve a common purpose with clearly defined functions and roles
- Promoting values for the authority and demonstrating the values of good governance through upholding high standards of conduct and behaviour
- Taking informed and transparent decisions which are subject to effective scrutiny and managing risk
- Developing the capacity and capability of members and officers to be effective
- Engaging with local people and other stakeholders to ensure robust public accountability



For more information about Surrey County Council, please visit: <https://www.surreycc.gov.uk/>

## About Aether

Aether are air quality and climate change emission consultants based in Oxford, with world expertise in environmental data analysis and interpretation. Aether is at the forefront of greenhouse gas (GHG) and air quality emissions calculation and review, in international, national and local authority markets. Serving a variety of markets from national governments to property developers, Aether is a highly skilled environmental consultancy firm continually expanding the projects they work on. Aether contributed to the content and the design of the Toolkit and supplementary workshops and assemblies.



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# List of Abbreviations

## Organisations and Programmes:

CA4SS	Cleaner Air for Secondary Schools
DEFRA	Department for Environment, Food & Rural Affairs
KS	Key Stage
LSx	London Sustainability Exchange
OPAL	Open Air Laboratories Network
STP	School Travel Plan
STARS	Sustainable Travel: Active, Responsible and Safe

## Pollutants:

CO	Carbon Monoxide
CO <sub>2</sub>	Carbon Dioxide
NO <sub>2</sub>	Nitrogen Dioxide
NO <sub>x</sub>	Nitrogen Oxides
PM <sub>2.5</sub>	Particulate Matter less than 2.5µm <sup>1</sup> in diameter
PM <sub>10</sub>	Particulate Matter less than 10µm <sup>1</sup> in diameter
SO <sub>2</sub>	Sulphur dioxide

<sup>1</sup> 1µm = 1 micrometres = 0.001mm

# Executive Summary

London Sustainability Exchange (LSx) presents the **Cleaner Air 4 Secondary Schools Toolkit** as created with funding and support from **Surrey County Council**. The Toolkit has been created along three subject areas in-line with the National Curriculum at **Key Stage 3** for **Science** and **Geography**, and **Key Stage 3** and **4** for **Citizenship**. Lesson plans, practical guidance and activities are provided. Subjects can be taught independently or interchangeably with each other.

**Cleaner Air 4 Secondary Schools (CA4SS)** is an engaging educational programme that aims to educate young people about the causes and effects of air pollution on health. In addition, this programme aims to inspire students to be aware of the changes they can make to reduce both their contribution and exposure to air pollution by adopting more sustainable means of transport (i.e. walking, cycling, alternative routes). CA4SS uses hands-on citizen science techniques to raise awareness of air pollution among the school community and develop student-led campaigns to explore and encourage behavioural changes.

CA4SS can be adapted to suit the school's needs, timeframe and budget. Many elements of the project can be delivered for free using the resources presented in this toolkit, however, it is recommended that for the Science module, schools invest in (low cost) scientific equipment to enrich the learning experience.

## The Cleaner Air 4 Secondary Schools (CA4SS):

- Offers a varied and tailored programme based on raising awareness and practical citizen science activities, involving measuring and monitoring air quality, as well as field trips, classroom-based activities, and homework activities
- Creates a connection between classroom science, geography and PSHE, and the related issues of air quality, energy and transport
- Enhances independent study skills and experience, important for achieving success at college and university
- Sets a foundation for further education and future employment prospects
- Support changes in transport behaviour in areas of high traffic density, as well as the development of school travel plans, including encouraging sustainable modes of transport, elements of road safety and avoiding poor air quality.

## Maximise impact & benefit of the project through:

- Teacher Champions – Crucial to the success of the project, is teacher involvement, championing, chasing and chivvy along students in between sessions
- Enabling Actions – Build these into the project structure from the beginning, trial sustainable travel, work with School Governors and external stakeholders
- Cross-curriculum learning – Make use of all three subject areas with their unique perspective
- Making use of your School Travel Plan if you have one, create one if you don't – This project can be a useful method to collect information and data for a School Travel Plan
- Enabling peer-to-peer learning – Share messages within and between schools, if permitted social media can be a great platform for this

## Background

Building on the success of the Cleaner Air 4 Primary School, **Cleaner Air 4 Secondary Schools (CA4SS)** was created by **London Sustainability Exchange (LSx)** in collaboration with East Hertfordshire District Council. The London Borough of Southwark commissioned LSx to deliver CA4SS to five secondary schools in Southwark and to develop a comprehensive Toolkit that can benefit schools across Southwark. At the same time, LSx worked with a second school in East Hertfordshire.

## Cleaner Air 4 Secondary Schools (CA4SS)

**Cleaner Air 4 Secondary Schools (CA4SS)** is an engaging educational programme that aims to educate young people about the causes and effects of air pollution on health through citizen science and inspires them to be aware of the changes they can make to reduce both their contribution and exposure to air pollution by adopting more sustainable means of transport such as walking, cycling and taking quieter routes.

CA4SS aims to reach beyond the classroom, to effect and inspire change that benefits the whole school community. The sessions are structured to:

- Improve the confidence and knowledge of students in understanding the importance of air quality
- Empower students to be able to practice air quality investigations using **citizen science**
- Help students in developing plans and take actions to rectify poor air quality

**Cleaner Air 4 Secondary Schools** complements extra-curricular activities such as the **Duke of Edinburgh**, the CREST Award, careers development and preparation for university entrance.

# Cleaner Air 4 Secondary School Toolkit

The Toolkit has been created along three subject areas in-line with the National Curriculum at **Key Stage 3** for **Science** and **Geography**, and **Key Stage 3** and **4** for **Citizenship**. Lesson plans, practical guidance and activities are provided. Subjects can be taught independently or interchangeably with each other. Lesson plans, practical guidance and activities are provided for each subject area.

The **session overviews** for the programme are outlined in Boxes 1 and 2.

## Box 1: Science Session Overview

Session	Overall Aim
<b>(Baseline)</b>	Conduct a Baseline Travel Survey as a precursor to the Air Quality Investigation
<b>Session 1 – Introduction</b>	Introduction to air quality, making predictions and plans for air quality assessment
<b>Session 2 – Investigation</b>	Conduct subject specific investigations making use of citizen science methods for different data collection activities
<b>Session 3 – Analysis &amp; Taking Action</b>	Draw conclusions from data collected and planning measures to abate air quality issues and putting them into practice
<b>(Follow up)</b>	Conduct a Follow Up Survey after putting measures and plans in place to abate air quality issues

## Box 2: Science Session Overview

Session	Overall Aim
<b>(Baseline)</b>	Conduct a Baseline Travel Survey as a precursor to the Air Quality Investigation
<b>Session 1 – Introduction</b>	Introduction to air quality, making predictions and plans for air quality assessment
<b>Homework or additional session - Investigation</b>	Conduct subject specific investigations making use of citizen science methods for different data collection activities
<b>Session 2 – Analysis &amp; Taking Action</b>	Draw conclusions from data collected and planning measures to abate air quality issues and putting them into practice
<b>(Follow up)</b>	Conduct a Follow Up Survey after putting measures and plans in place to abate air quality issues

# Cleaner Air 4 Secondary Schools Programme

## Timeframe

CA4SS can be integrated into existing lessons, for example it fits comfortably in science, geography or citizen modules or completed as part of an extracurricular activity. Given the environmental focus, it is popular among Green Teams or the Eco-committee. The programme could be extended across a specific year group or to the entire school with different classes carrying out different activities. It can be delivered wholesale or piecemeal. Tables 2 and 3 set out example timeframes for CA4SS.

**Table 2: Timeframe for CA4SS – KS3 Science**

	Weeks										
	0	1	2	3	4	5	6	7	8	9	10
<b>Topics</b>	Preparation	Introducing Air Quality and Planning an Investigation	Investigating Air Quality						Data Analysis and Taking Action		Monitoring and Reporting
<b>Stretch Activities</b>		Exploring the Respiratory System	Travel and Idling Survey								
<b>Citizen Science</b>			NO <sub>2</sub> Diffusion Tubes						Analysing Results		
<b>Taking Action</b>									Air Quality Champions Writing a Letter to Local Authorities Social Media Reverse Graffiti Posters/Newsletter Videos/Photography		

**Table 3: Timeframe for CA4SS – KS3 Geography, KS3 / KS4 Citizenship**

	Weeks					
	0	1	2	3	4	5
<b>Topics</b>	Preparation	Introducing Air Quality and Planning an Investigation	Investigating Air Quality	Data Analysis and Taking Action		Monitoring and Reporting
<b>Stretch Activities</b>		Investigating the Great Smog 1952	Travel and Idling Surveys	Data Analysis of Lichens for Environmental Change		
<b>Citizen Science Taking Action</b>			Lichen Study	Analysing Results		
				Air Quality Champions Writing a Letter to Local Authorities Social Media Reverse Graffiti Posters/Newsletter Videos/Photography		

## Cleaner Air 4 Schools Lesson Plans Overview

The following pages provide complete lesson plans for the three subject areas. Each plan details the unit of the work, the individual lessons and stretch learning activities.

# Air Quality Investigation for KS3 Science

## Unit of Work: Overview

In session one, your students will learn about the Great Smog of 1952 and the dangers of air pollution today. Students will be introduced to the make-up of the air we breathe and its most common pollutants. They will then investigate the causes of these pollutants and learn the ways in which poor air quality can best be measured and tested. They will learn about sampling and work scientifically to design an experiment that tests air quality in their local area.

In the second session, your students will then carry out an experiment that measures levels of nitrogen dioxide (NO<sub>2</sub>) in a number of locations in and around your school grounds.

The third session must take place four to six weeks after the NO<sub>2</sub> diffusion tubes are placed. Your students will start this session by learning about an example of successful citizen action against air pollution. They will then analyse, critique and present the information gathered in their research. Finally, your students will select a course of action to take with the aim of improving the air quality of their local area.

Before Session One, and after Session Three, conduct the Baseline Survey and Follow-Up Surveys with your students to monitor and evaluate the Air Quality Investigation learning (See Appendix 2.1).

NB: NO<sub>2</sub> diffusion tubes will need to be purchased for this unit of work. See Appendix 5 for supplier details.

## Learning Outcomes

- Ask questions and develop a line of enquiry based on observations, and make predictions using scientific knowledge
- Use appropriate techniques, apparatus and materials during fieldwork
- Make and record observations and measurements using a range of methods, and apply sampling techniques
- **Biology:** how organisms affect, and are affected by, their environment, including the accumulation of toxic materials
- **Chemistry:** the composition of the atmosphere, the production of carbon dioxide and other gases by human activity and their impact

## You Will Need

- Scissors and Sellotape
- Maps of your local area
- A computer screen
- Internet access
- NO<sub>2</sub> diffusion tubes, diffusion tube clips and investigation sites
- Risk assessment for fieldwork

## You Will Need

Three sessions of one hour. The second of these sessions involves fieldwork.

## Session One

### ❖ Opener: Great Smog of 1952 (5 mins)

As your class comes in, display a gallery of images from the Great Smog of 1952. The Guardian has a good collection: [www.tinyurl.com/smog1952](http://www.tinyurl.com/smog1952).

Explain that smog is a kind of polluted fog. In 1952, fog mixed with the enormous amounts of pollution from factories and power stations and smoke from domestic coal used for heating, which created a highly toxic blend. This smog was so toxic and thick that it brought traffic to a standstill, asphyxiated cows at Smithfield Market, and led to many people experiencing breathing problems and resulted in at least 4,000 human deaths in a period of a few days.

The terrible conditions and resulting deaths caused public outrage. In response, parliament passed the Clean Air Act of 1956, banning emissions of black smoke and requiring all factories and urban households to use smokeless fuels. Power stations like Battersea and Bankside were closed down.

#### Fact!

Equivalent of 471 premature deaths per year can be attributed to long-term exposure to particulates (PM) in Surrey.

### ❖ Group Work: Continuum of Death (10 mins)

Split your class into pairs or groups and distribute scissors and Worksheet one: *Continuum of Death* (see Appendix 1.1). Ask your students to cut out the different causes of death and place them along the continuum based on number of deaths per year in the UK. For *Fraction of Mortality in Surrey* graph (looking at the impact of PM Pollution on health) see Appendix 1.2a.

#### Fact!

More than 1 in 4 children aged 10-11 are overweight or obese in Surrey, which could be improved by walking to school. An increase in walking would help to support the Surrey Healthy Weight Strategy for Children, Young People and Families 2017-2022.

### ❖ Class Discussion: Air Pollution (10 mins)

Did the class expect air pollution to be so deadly? Does the air they are breathing now look as polluted as it did in the Great Smog? Ask your class to take a deep breath and think about what is going into their lungs. Air is a mixture of gases, which we inhale thousands of times a day. The mixture changes depending on where we are and what we (or others) are doing.

Distribute Worksheet two: *The Air That We Breathe* (see Appendix 1.2b) and talk your students through the basic make up of air and the listed pollutants. Based on this information, where might they find places of air pollution? Write any answers on your whiteboard.

### ❖ Classwork: Designing an Experiment (35 mins)

In Europe, the amount of NO<sub>2</sub> is not supposed to exceed 40 micrograms (µg) per cubic metre (m<sup>3</sup>). However, readings taken in cities are often over double the legal limit. See Appendix 1.7a for graph of NO<sub>2</sub> levels by district in Surrey (explaining some exceed this legal limit of 40). Show your class a sample NO<sub>2</sub> diffusion tube. Using Teacher notes two: *Using NO<sub>2</sub> diffusion tubes* (see Appendix 1.7b) as a guide, explain that it is a device that determines NO<sub>2</sub> concentration levels, and that they will be distributing a few of them in and around the school grounds.

Ask your students to get into groups and then distribute maps of your school grounds and surrounding areas. Ask them

to label areas that they expect to see highest and lowest levels of different types of air pollution. Where might be the best places to put an NO<sub>2</sub> diffusion tube? Think about where they go and spend time (i.e. bus stops and park).

Hand out Worksheet three: *Fair Experiment Checklist* (see Appendix 1.3). Explain that there are a number of factors that could influence their results, so we must plan a fair experiment. If appropriate, you can introduce the different ways of sampling here when discussing methods.

Your students should ensure that the location of the NO<sub>2</sub> diffusion tubes should be the only independent variable. How will they control for other factors? Prompt your students to think about the height of the tubes and how exposed it is on each side. The checklist should be completed in preparation for the next session. Also see Appendix 2.4 for instructions on measuring NO<sub>2</sub> with diffusion tubes.

### Stretch Learning

Take a look at how gases and particulate matter enter the respiratory system then think about why particles less than 2.5 micrometres in diameter (far smaller than a single human hair at 100 micrometres) are so dangerous?

### Fact!

There are 26 Air Quality Management Areas (AQMAs) in Surrey. These are places monitored as they have been declared as not meeting air quality objectives.

See Appendix 1.2.

## Session 2

### ❖ Opener: Final Experiment Preparation (15 mins)

As a class, revisit Worksheet three: *Fair Experiment Checklist* (Appendix 1.3), ensuring your students have carefully thought about controlling the variables. Next, hand out Worksheet four: *Diffusion Tube Record* (see Appendix 1.4) along with the NO<sub>2</sub> diffusion

tubes and their fittings. Finally, work with your students to decide the locations for the NO<sub>2</sub> diffusion tubes based on the mapping exercise they did in the last session.

### ❖ Fieldwork: Installing NO<sub>2</sub> Diffusion Tubes (45 mins)

Depending on the context of your classroom, you may decide to allow your students to work in groups installing the NO<sub>2</sub> diffusion tubes, or you may wish to work as a full class. In either case, ensure your students document the installation correctly using Worksheet four: *Diffusion Tube Record* (Appendix 1.4). Make sure your students label the tubes correctly and make good notes about each of the chosen locations, including geographic data, photography and/or annotated sketches, and site use (e.g. car park, bus stop, open field). Ensure that the time of the start of the diffusion tube exposure is recorded by the students.

Ensure you know where the tubes are located: you'll need them to prep for session three. Ideally, the diffusion tube exposure period should be a month but can be collected after two weeks. After two to four weeks, you should collect the diffusion tubes, recording the end time and date of the exposure. The tubes will then need to be sent to the laboratory for analysis.

Finally, read the instructions in the Before the session starts section of the next session.

### Stretch Learning

Use the Traffic and Idling Surveys to explore the causes of air pollution around the school (see Appendix 2.5).

## Session 3

### ❖ Before the Session Starts (10 mins)

Please note: this final session should be scheduled for at least six weeks after the last session. At least two weeks after session two (but ideally four weeks), and at least two weeks before session three, the diffusion tubes must be collected. Send the labelled tubes and monitoring sheets to your supplier. Before session three you should have received your diffusion tube results as a CSV file.

### ❖ Opener: Reverse Graffiti (5 mins)

As students come in, show a short video or display images of Brazilian artist Alexandre Orion's work (<https://www.youtube.com/watch?v=JwsBBIIXT0E>). He chose to protest about his city's pollution levels using reverse graffiti: cleaning patterns in the residue the pollution left on the walls. When the police came to investigate, they listened to his arguments and ended up protecting the artist from traffic as he worked. The art sparked a big conversation about air quality and pollution, and as a result the city council cleaned up every tunnel in the city.

#### Fact!

Road traffic is one of the major contributions to air pollution in Surrey with almost half of households having 2 or more cars.

### ❖ Individual/Group Work: Examining Results (45 mins)

Divide your class into groups and hand out the results. What is the most interesting/useful way to display results? You may ask students to create a map or have one prepared beforehand. For inspiration, display or hand out Worksheet five: *Mapping Air Pollution* (see Appendix 1.5).

Use the map on Worksheet five: *Mapping Air Pollution* and your own results as a basis for a class discussion. Ask your students to think about why the results are the way they are.

- What causes pollution?
- Why are the results so different?
- Can you identify any patterns in the data?
- Are there any anomalies?
- Are you surprised by any of these results?

Divide the class back into groups or pairs and ask students to work in more depth on the evidence to produce a report that communicates their findings and suggests ways the school and local community can take positive action based on the evidence from the experiment. The report should include the following:

- An introduction to the experiment
- An explanation of their methodology
- An accurate map with annotations
- Their interpretation of the results

### ❖ Individual/Group Work: Take Action (10 mins)

Now that your students have an understanding of the dangers of air pollution and evidence of different levels of air quality in their local area, ask them if they think they can positively impact their area in a similar way to Alexandre Orion? Ask each student or group to choose one action to take – or they can come up with their own! Ask each student or group to choose one action to take, to be started in class and completed as homework. See Appendix 3 for examples of Community Action Planning. Examples are:

- Write to your MP ([www.theyworkforyou.com](http://www.theyworkforyou.com)) with your

evidence. Attach your report and tell them what action you want them to take. They should reply!

- Get permission to reverse graffiti a message about air pollution. You can do this using a sturdy stencil, a wire brush and some ecologically friendly detergent.
- Remix the BBC News website with Mozilla X-Ray Goggles, a free to use web application that makes it easy to see and remix the code behind web pages. Write your own news articles about air pollution with photos of your local area. Make a screen grab and share it on social media.
- Present your findings to the rest of the school with a marketing campaign including posters and talking at an assembly.
- Share your sustainable journey to school making a video, animation or using time lapse photography. Publish it to YouTube.

## Practical Guidance Timeframe

Week 0 – Preparation and Baseline Survey  
Week 1 – Session 1 and Stretch Learning  
Week 2 – Session 2, installing diffusion tubes and stretch learning  
Week 6 – Collect tubes and send off to lab  
Week 8 – Session 3  
Week 9/10 – Follow up survey

## Suppliers and Useful Links

- Smog Images [www.tinyurl.com/smog1952](http://www.tinyurl.com/smog1952)
- Local Authority diffusion tube monitoring info <https://laqm.defra.gov.uk/diffusion-tubes/data-entry.html>
- Diffusion Tube Sampling See Appendix 5 for supplier list
- Reverse Graffiti <https://www.youtube.com/watch?v=JwsBBIIXT0E>
- Mozilla X-Ray Goggles <https://goggles.mozilla.org/>

## Worksheets/Teachers Notes

Pre-Sessions: Baselines Survey

Session 1:

- Worksheet 1: Continuum of Death
- Teachers Notes 1: Continuum of Death
- Worksheet 2: The air we breathe
- Worksheet 3: Fair Experiment Checklist

Session 2:

- Worksheet 3: Fair Experiment Checklist
- Worksheet 4: Diffusion Tube Record
- Teachers Notes 2: Using NO<sub>2</sub> diffusion tubes

Session 3:

- Worksheet 5: Mapping Air Pollution

Post Sessions: Follow Up Survey

# Air Quality Investigation for KS3 Geography

## Unit of Work: Overview

In session one, your students will learn about the Great Smog of 1952 and the dangers of air pollution today. Students will be introduced to the make-up of the air we breathe and its most common pollutants. They will then investigate the causes of these pollutants and think about how physical signs of poor air quality can be seen in the landscape. Finally, they will use this knowledge to design a piece of fieldwork that searches for evidence of the levels of air quality in their local area.

Your students will then take part in a piece of fieldwork that looks for different species of lichen on trees. This fieldwork can be carried out as homework or completed in an additional session before session two.

In session two, your students will start the session by learning about an example of successful citizen action against air pollution. They will then analyse and present the information gathered in the fieldwork using geographic information, reporting, images, charts and graphs. Finally, your students will select a course of action to take with the aim of improving the air quality of their local area.

Before Session One, and after Session Two, conduct the Baseline Survey and Follow-Up Surveys with your students to monitor and evaluate the Air Quality Investigation learning (See Appendix 2.1).

## Learning Outcomes

- Collect, analyse and communicate with a range of data gathered through fieldwork that deepen their understanding of geographical processes
- Communicate geographical information in a variety of ways
- Interpret Ordnance Survey, Google, or Google Earth Maps in the classroom and the field, including using grid references
- Use fieldwork in contrasting locations to collect, analyse and draw conclusions from geographical data, using multiple sources of information

## You will need

- Scissors and Sellotape
- Maps of your local area
- A computer screen
- Internet access
- Risk assessment for fieldwork

## Suggested minimum time

Three sessions of one hour plus additional fieldwork which can be set as homework or completed in an extra session of one hour.

## Session One

### ❖ Opener: Great Smog of 1952 (10 mins)

As your class comes in, display a gallery of images from the Great Smog of 1952. The Guardian has a good collection: [www.tinyurl.com/smog1952](http://www.tinyurl.com/smog1952).

Explain that smog is a kind of polluted fog. In 1952, fog mixed with the enormous amounts of pollution from factories and power stations and smoke from domestic coal used for heating, which created a highly toxic blend. This smog was so toxic and thick that it brought traffic to a standstill, asphyxiated cows at Smithfield Market, and led to many people experiencing breathing problems and resulted in at least 4,000 human deaths in a period of a few days.

The terrible conditions and resulting deaths caused public outrage. In response, parliament passed the Clean Air Act of 1956, banning emissions of black smoke and requiring all factories and urban households to use smokeless fuels. Power stations like Battersea and Bankside were closed down.

### Stretch Learning

Use the Met Office's case study ([www.tinyurl.com/smogmet](http://www.tinyurl.com/smogmet)) as a starting point for a more in-depth investigation of the weather conditions that, combined with terrible air pollution, led to the Great Smog of 1952.

### Fact!

Equivalent of 471 deaths per year can be attributed to long-term exposure to particulates (PM) in Surrey.

### ❖ Group Work: Continuum of Death (10 mins)

Split your class into pairs or groups and distribute scissors and Worksheet one: *Continuum of Death* (see Appendix 1.1). Ask your students to cut out the different causes of

death and place them along the continuum based on number of deaths per year in the UK. For *Fraction of Mortality in Surrey* graph (looking at the impact of PM Pollution on health) see Appendix 1.2a.

### Fact!

More than 1 in 4 children aged 10-11 are overweight or obese in Surrey, which could be improved by walking to school. An increase in walking would help to support the Surrey Healthy Weight Strategy for Children, Young People and Families 2017-2022.

### ❖ Class Discussion: Air Pollution (10 mins)

Did the class expect air pollution to be so deadly? Does the air they are breathing now look as polluted as it did in the Great Smog? Ask your class to take a deep breath and think about what is going into their lungs. Air is a mixture of gases, which we inhale thousands of times a day. The mixture changes depending on where we are and what we (or others) are doing.

Distribute Worksheet two: *The Air That We Breathe* (see Appendix 1.2b) and talk your students through the basic make up of air and the listed pollutants. Based on this information, where might they find places of air pollution? Write any answers on your whiteboard.

### Fact!

46.4% of households in Surrey have access to 2 or more cars, significantly higher than 32% nationally.

### ❖ Classwork: Designing fieldwork (20 mins)

Tell your class that they are going to be testing their expectations of air pollution levels in their local area. Ask your students to get into groups and distribute maps of your school grounds and the surrounding area. Maps can be obtained through

Google Maps or existing school resources. Ask them to label areas that they expect to show high or low levels of different types of air pollution. While they are doing this, give out copies of the OPAL lichen guide:

[www.tinyurl.com/lichenAQ](http://www.tinyurl.com/lichenAQ).

See Appendix 2.3 for a copy of the Lichen Monitoring Guide and Identification Sheet.

Depending on the time available you can choose to design a piece of group fieldwork for the next lesson that explores the school grounds and local area using the Lichen Monitoring Guide and Identification Sheet or set homework that asks students to look for indicators of pollution using the Lichen resources near home.

Ask the class to think about their fieldwork carefully. Further notes, suggested prompts and fieldwork guidelines are provided in Teachers notes three: Designing fieldwork (see Appendix 1.9).

### Stretch Learning

Use the Traffic and Idling Surveys to explore the causes of air pollution around the school (See Appendix 2.5).

### Fact!

Nitrogen deposition can be harmful to the environment, leading to eutrophication which significantly impacts Surrey as a county – Surrey has 3 national nature reserves and 42 local nature reserves.

## Session Two

### ❖ Opener: Reverse Graffiti (5 mins)

As students come in, show a short video or display images of Brazilian artist Alexandre Orion's work (<https://www.youtube.com/watch?v=JwsBBIIXT0E>). He chose to protest about his city's pollution levels using reverse graffiti: cleaning patterns in the residue the pollution left on the walls. When the police came to investigate,

they listened to his arguments and ended up protecting the artist from traffic as he worked. The art sparked a big conversation about air quality and pollution, and as a result the city council cleaned up every tunnel in the city.

### ❖ Individual/Group Work: Examining Results (40 mins)

Now that your students have completed their fieldwork, help them make sense of the findings. Tell your class that they are going to examine and analyse the data they collected, and then compare the conditions at each site they visited. If your students did this fieldwork individually as homework, they can work on their own results, but if you did this as a class, you can split the class into groups.

Ask your students to fill in a copy of Worksheet three: *Examining results* (see Appendix 1.8) for each site they visited. Once they have completed the worksheets, ask them to display the information in the totals column, using an appropriate graph. What differences can you see in evidence collected at both sites? What does that mean? Does the evidence line up with their expectations?

### Stretch Learning

Ask your students if they can spot any differences between the lichens found on the trunk, branches and twigs. Explain that the trunk is the oldest part of the tree and twigs are the youngest. If the students find differences between the lichens found on the different part of the trees, it may well indicate changes to the environment in recent times.

### ❖ Group/Individual work: Take Action (15 mins)

Now that your students have an understanding of the dangers of air pollution and evidence of different levels of

air quality in their local area, ask them if they think they can positively impact their area in a similar way to Alexandre Orion? Here are some ideas for actions your students can take - or they can come up with their own! Ask each student or group to choose one action to take, to be started in class and completed as homework. See Appendix 3 for examples of Community Action Planning.

- Write to your MP ([www.theyworkforyou.com](http://www.theyworkforyou.com)) with your evidence. Attach your report and tell them what action you want them to take. They should reply!
- Get permission to reverse graffiti a message about air pollution. You can do this using a sturdy stencil, a wire brush and some ecologically friendly detergent.
- Remix the BBC News website with Mozilla X Ray Goggles, a free to use web application that makes it easy to see and remix the code behind web pages. Write your own news articles about air pollution with photos of your local area. Make a screen grab and share it on social media.
- Present your findings to the rest of the school with a marketing campaign including posters and talking at an assembly.
- Share your sustainable journey to school by making a video, animation or using time lapse photography. Publish it to YouTube.

## Practical Guidance

### Timeframe

Week 0 – Preparation and Baseline Survey  
Week 1 – Session 1 and Stretch Learning  
Week 2 – Lichen Fieldwork (homework or extra session)  
Week 3 – Session 2 and Stretch Learning  
Week 4 – Follow up survey

### Useful Links

- Smog Images  
[www.tinyurl.com/smog1952](http://www.tinyurl.com/smog1952)
- Reverse Graffiti  
<https://www.youtube.com/watch?v=JwsBBIIXTOE>
- Mozilla X-Ray Goggles  
<https://goggles.mozilla.org/>
- Google Maps [www.google.com/maps](http://www.google.com/maps)

### Worksheets/Teachers Notes

Pre-Sessions: Baselines Survey

Session 1:

- Worksheet 1: Continuum of Death
- Teachers Notes 1: Continuum of Death
- Worksheet 2: The air we breathe
- Worksheet 3: Designing Fieldwork

Session 2:

- Worksheet 3: Examining Results

Post Sessions: Follow Up Survey

# Air Quality Investigation for KS3 or KS4 Citizenship

## Unit of Work: Overview

In session one, your students will learn about the Great Smog of 1952 and the dangers of air pollution today. They will be introduced to the make-up of air and its most common pollutants. They will then think about how to find evidence of poor air quality and use this learning to design a piece of research that searches for pollution in their local area.

Your students will then take part in a piece of research that looks for different species of lichen on trees. This research can be carried out as homework or completed in an additional session before session two.

In session two, your students will start the session by learning about an example of successful citizen action against air pollution. They will then analyse and present the information gathered in their research. Finally, your students will select a course of action to take with the aim of improving the air quality in their local area.

Before session one, and after session two, conduct the Baseline Survey and Follow-Up Surveys with your students to monitor and evaluate the Air Quality Investigation learning (See Appendix 2).

## Learning Outcomes

- Knowledge and understanding of how citizens can participate actively in the democratic systems
- Develop an interest in, and commitment to, participation in volunteering as well as other forms of responsible activity
- Learn about and take part in the ways in which citizens work together to improve their communities
- Provision of opportunities to participate in school or community-based activities

## You Will Need

- Scissors and Sellotape
- Maps of your local area
- Internet access
- Risk assessment for fieldwork

## Suggested Minimum Time

Two sessions of one hour plus additional fieldwork which can be set as homework or completed in an extra session of one hour.

## Session One

### ❖ Opener: Great Smog of 1952 (10 mins)

As your class comes in, display a gallery of images from the Great Smog of 1952. The Guardian has a good collection: [www.tinyurl.com/smog1952](http://www.tinyurl.com/smog1952).

Explain that smog is a kind of polluted fog. In 1952, fog mixed with the enormous amounts of pollution from factories and power stations and smoke from domestic coal used for heating, which created a highly toxic blend. This smog was so toxic and thick that it brought traffic to a standstill, asphyxiated cows at Smithfield Market, and led to many people experiencing breathing problems and resulted in at least 4,000 human deaths in a period of a few days.

The terrible conditions and resulting deaths caused public outrage. In response, parliament passed the Clean Air Act of 1956, banning emissions of black smoke and requiring all factories and urban households to use smokeless fuels. Power stations like Battersea and Bankside were closed down.

### Stretch Learning

Ask students to think about why it took four years to pass the Clean Air Act. They should consider industry pressure, economic reasons, practical concerns and political difficulties. Can they see any parallels with modern issues?

### ❖ Group Work: Continuum of Death (10 mins)

Split your class into pairs or groups and distribute scissors and Worksheet one: *Continuum of Death* (see Appendix 1.1). Ask your students to cut out the different causes of death and place them along the continuum based on number of deaths per year in the UK.

Once your students have had some time to complete this activity, ask the class to help you arrange the causes of death at the front of the class. Referring to Teacher notes one: Continuum of Death (see Appendix 1.6) for the statistics, you can then re-arrange the causes of death in the correct order. For *Fraction of Mortality in Surrey* graph (looking at the impact of PM Pollution on health) see Appendix 1.2a.

### ❖ Class Discussion: Air Pollution (10 mins)

Did the class expect air pollution to be so deadly? Does the air they are breathing now look as polluted as it did in the Great Smog? Ask your class to take a deep breath and think about what is going into their lungs. Air is a mixture of gases, which we inhale thousands of times a day. The mixture changes depending on where we are and what we (or others) are doing.

Distribute Worksheet two: *The Air That We Breathe* (see Appendix 1.2b) and talk your students through the basic make up of air and the listed pollutants. Based on this information, where might they find places of air pollution? Write any answers on your whiteboard.

### ❖ Classwork: Designing Fieldwork (20 mins)

Tell your class that they are going to be testing their expectations of air pollution levels in their local area. Ask your students to get into groups and distribute maps of your school grounds and the surrounding area. Maps can be obtained through Google Maps or existing school resources. Ask them to label areas that they expect to show high or low levels of different types of air pollution. While they are doing this, give out copies of the OPAL lichen guide: [www.tinyurl.com/lichenAQ](http://www.tinyurl.com/lichenAQ).

See Appendix 2.3 for a copy of the Lichen Monitoring Guide and Identification Sheet.

Depending on the time available you can choose to design a piece of group fieldwork for the next lesson that explores the school grounds and local area using the Lichen Monitoring Guide and Identification Sheet or set homework that asks students to look for indicators of pollution using the Lichen resources near home.

Ask the class to think about their fieldwork carefully. Further notes, suggested prompts and fieldwork guidelines are provided in Teachers notes three: Designing fieldwork (see Appendix 1.9).

### Stretch Learning

Use the Traffic and Idling Surveys to explore the causes of air pollution around the school (See Appendix 2.5).

### Fact!

An anti-idling campaign was launched in Surrey, with banners placed around Reigate level crossing. Pollution levels near the level crossing were seen to have fallen.

## Session Two

### ❖ Opener: Reverse Graffiti (5 mins)

As students come in, show a short video or display images of Brazilian artist Alexandre Orion's work (<https://www.youtube.com/watch?v=JwsBBIIXT0E>). He chose to protest about his city's pollution levels using reverse graffiti: cleaning patterns in the residue the pollution left on the walls. When the police came to investigate, they listened to his arguments and ended up protecting the artist from traffic as he worked. The art sparked a big conversation about air quality and pollution, and as a result the city council cleaned up every tunnel in the city.

### ❖ Individual/Group Work: Examining Results (25 mins)

Now that your students have completed their fieldwork, help them make sense of the findings. Tell your class that they are going to examine and analyse the data they collected, and then compare the conditions at each site they visited. If your students did this fieldwork individually as homework, they can work on their own results, but if you did this as a class, you can split the class into groups.

Ask your students to fill in a copy of Worksheet three: *Examining results* (see Appendix 1.8) for each site they visited. Once they have completed the worksheets, ask them to display the information in the totals column, using an appropriate graph. What differences can you see in evidence collected at both sites? What does that mean? Does the evidence line up with their expectations?

### Stretch Learning

Ask your students if they can spot any differences between the lichens found on the trunk, branches and twigs. Explain that the trunk is the oldest part of the tree and twigs are the youngest. If the students find differences between the lichens found on the different part of the trees, it may well indicate changes to the environment in recent times.

### Fact!

Road traffic is one of the major contributions to air pollution in Surrey with almost half of households having 2 or more cars.

### ❖ Group/Individual Work: Take Action (15 mins)

Now that your students have an understanding of the dangers of air pollution and evidence of different levels of

air quality in their local area, ask them if they think they can positively impact their area in a similar way to Alexandre Orion? Here are some ideas for actions your students can take - or they can come up with their own! Ask each student or group to choose one action to take, to be started in class and completed as homework. See Appendix 3 for examples of Community Action Planning.

- Write to your MP ([www.theyworkforyou.com](http://www.theyworkforyou.com)) with your evidence. Attach your report and tell them what action you want them to take. They should reply!
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- Remix the BBC News website with Mozilla X Ray Goggles, a free to use web application that makes it easy to see and remix the code behind web pages. Write your own news articles about air pollution with photos of your local area. Make a screen grab and share it on social media.
- Present your findings to the rest of the school with a marketing campaign including posters and talking at an assembly.
- Share your sustainable journey to school by making a video, animation or using time lapse photography. Publish it to YouTube.

## Practical Guidance

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Week 2 – Lichen Fieldwork (homework or extra session)

Week 3 – Session 2 and Stretch Learning

Week 4 – Follow up survey

### Useful Links

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[www.tinyurl.com/smog1952](http://www.tinyurl.com/smog1952)
- Reverse Graffiti  
<https://www.youtube.com/watch?v=JwsBBIIXTOE>
- Mozilla X-Ray Goggles  
<https://goggles.mozilla.org/>
- Google Maps [www.google.com/maps](http://www.google.com/maps)

### Worksheets/Teachers Notes

Pre-Sessions: Baselines Survey

Session 1:

- Worksheet 1: Continuum of Death
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- Worksheet 2: The air we breathe
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Session 2:

- Worksheet 3: Examining Results

Post Sessions: Follow Up Survey

# Appendix 1 Lesson Worksheets and Teachers Notes

## Appendix 1.1 Worksheet one: Continuum of Death



BEE STINGS

AIR POLLUTION

LIGHTNING

ALCOHOL

SMOKING

DROWNING

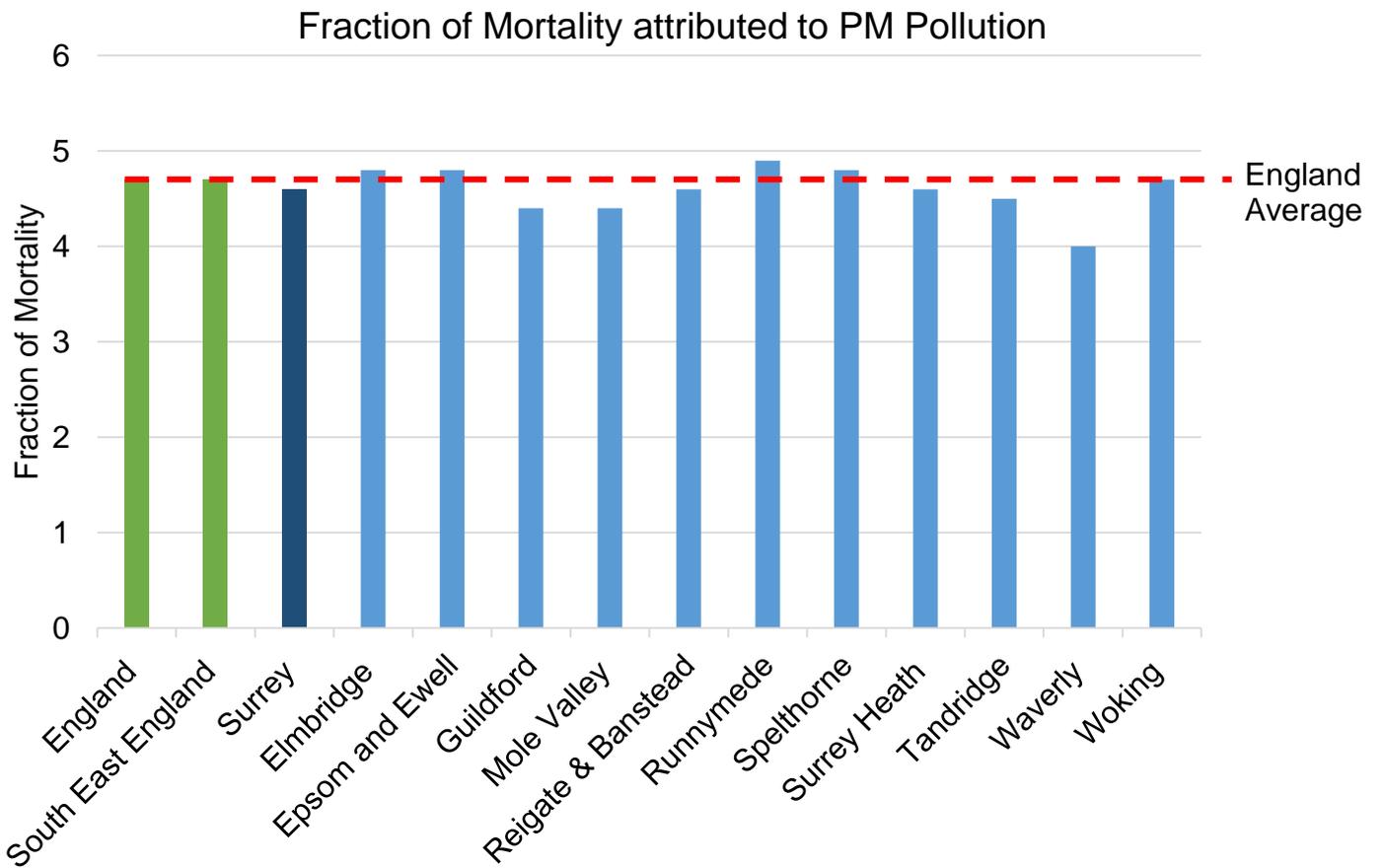
TRAFFIC ACCIDENTS

ILLEGAL DRUGS

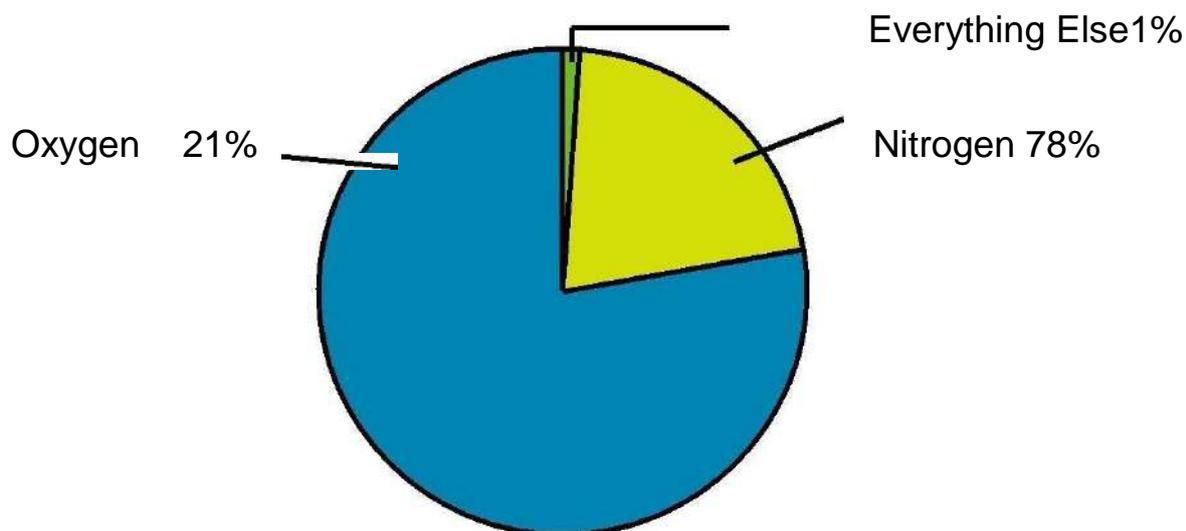
SELFIES

OBESITY

## Appendix 1.2a Fraction of Mortality in Surrey – attributed to PM Pollution



## Appendix 1.2b Worksheet two: The Air That We Breathe

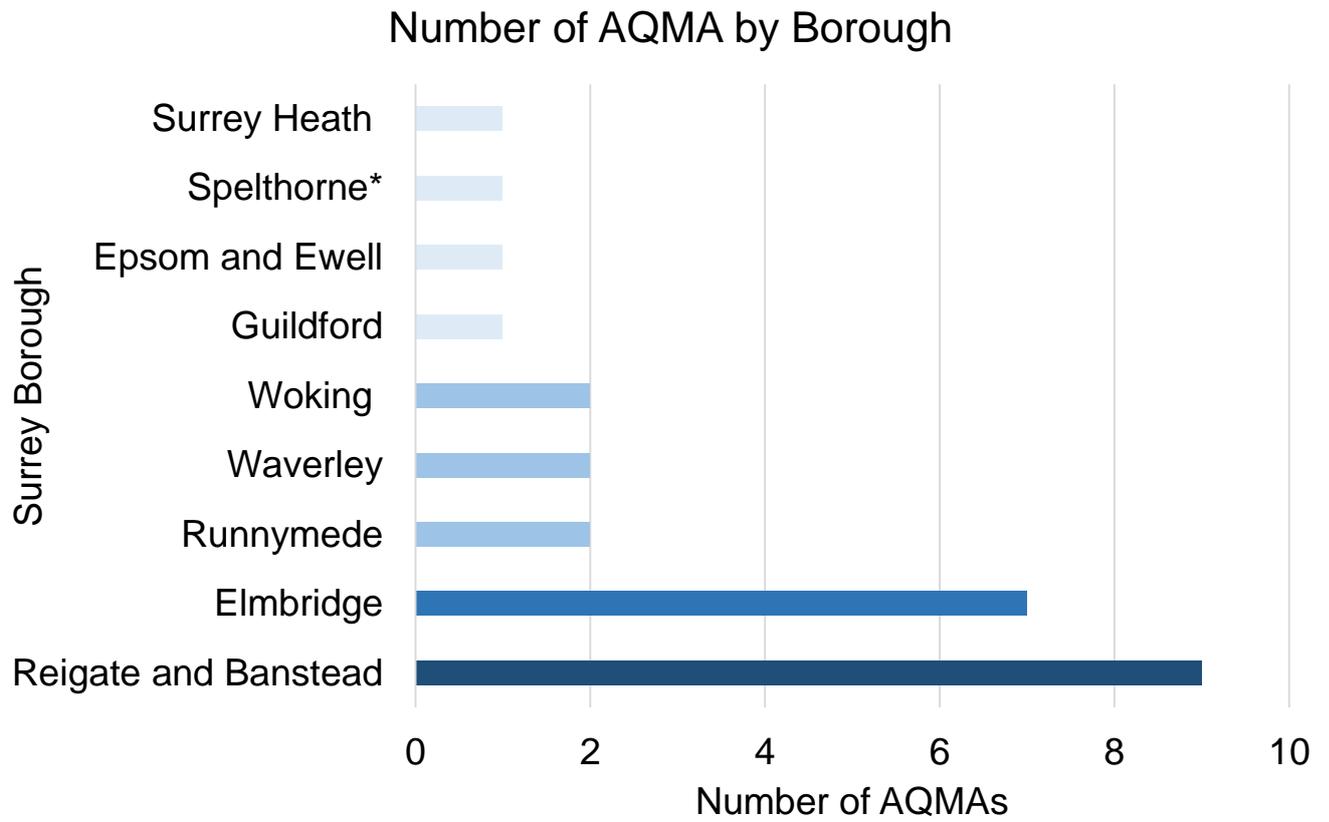


The most common trace elements are argon at 0.93% and carbon dioxide at 0.04%. Water vapour varies depending upon the temperature and humidity, ranging from 0.1% to over 4%.

### Pollutants

- **PM<sub>2.5</sub> and PM<sub>10</sub>: Particulates** - Particulates aren't gases but lots of bits floating around in our air, including aerosols, smoke, fumes, dust, ash and pollen. Particulate matter is sorted according to size because of the different health effects associated with particles of different sizes. PM<sub>2.5</sub> (smaller than 2.5 micrometres) is classified as fine particulate matter, while PM<sub>10</sub> (smaller than 10 micrometres) is classified as coarse particulate matter. PM<sub>2.5</sub> is the most dangerous because it goes much further into the respiratory system, contributing to heart and lung disease.
- **NO and NO<sub>2</sub>: Nitric oxide and Nitrogen Dioxide** - Produced from car exhausts, burning fuel in power plants and as a by-product of thunderstorms. They are both very toxic. Attributed to decreased immune systems and increased asthma symptoms. High concentrations can contribute to acid rain and depletion of the ozone layer. Inhaling NO<sub>2</sub> will poison you at higher doses.
- **SO<sub>2</sub>: Sulphur dioxide** - This smelly chemical comes from volcanoes, factories and burning coal. It is highly toxic, resulting in a range of respiratory conditions. It is also used to make sulphuric acid, which contributes to acid rain. It is used in very small doses to preserve apricots and help make wine.
- **CO: Carbon monoxide** - This harmful toxin comes from burning fossil fuels. You'll find it wherever there are cars, taxis, buses, or fires. It causes headaches, fainting and eventually suffocation.
- **CO<sub>2</sub>: Carbon dioxide** - You breathe this out. At high enough doses it has the same toxic result as CO. Increased CO<sub>2</sub> is why a room filled with people feels stuffy (besides temperature). Other sources of CO<sub>2</sub> are fires, waste incineration, volcanoes and aeroplanes. CO<sub>2</sub> causes global warming.

## Appendix 1.2c AQMAs in Surrey



\*The whole borough of Spelthorne has been declared an AQMA

## Appendix 1.3 Worksheet 3a: Fair Experiment Checklist

- Experiment details:  
(Overview of the experiment, where it will be and how long it will run for)
  
- Hypothesis:  
(What you think will happen)
  
- Method:  
(What you will do)
  
- Independent variable:  
(What you will change)
  
- Dependent variables:  
(What will respond to the independent variable)
  
- Controlled variables:  
(What needs to stay the same)

### Appendix 1.4 Worksheet four: Diffusion Tube Record

Start of Exposure Date and Time	End of Exposure Date and Time	Tube Code	Location Data	Site Information and Notes

Start of Exposure Date and Time	End of Exposure Date and Time	Tube Code	Location Data	Site Information and Notes

## Appendix 1.5 Worksheet five: Mapping Air Pollution

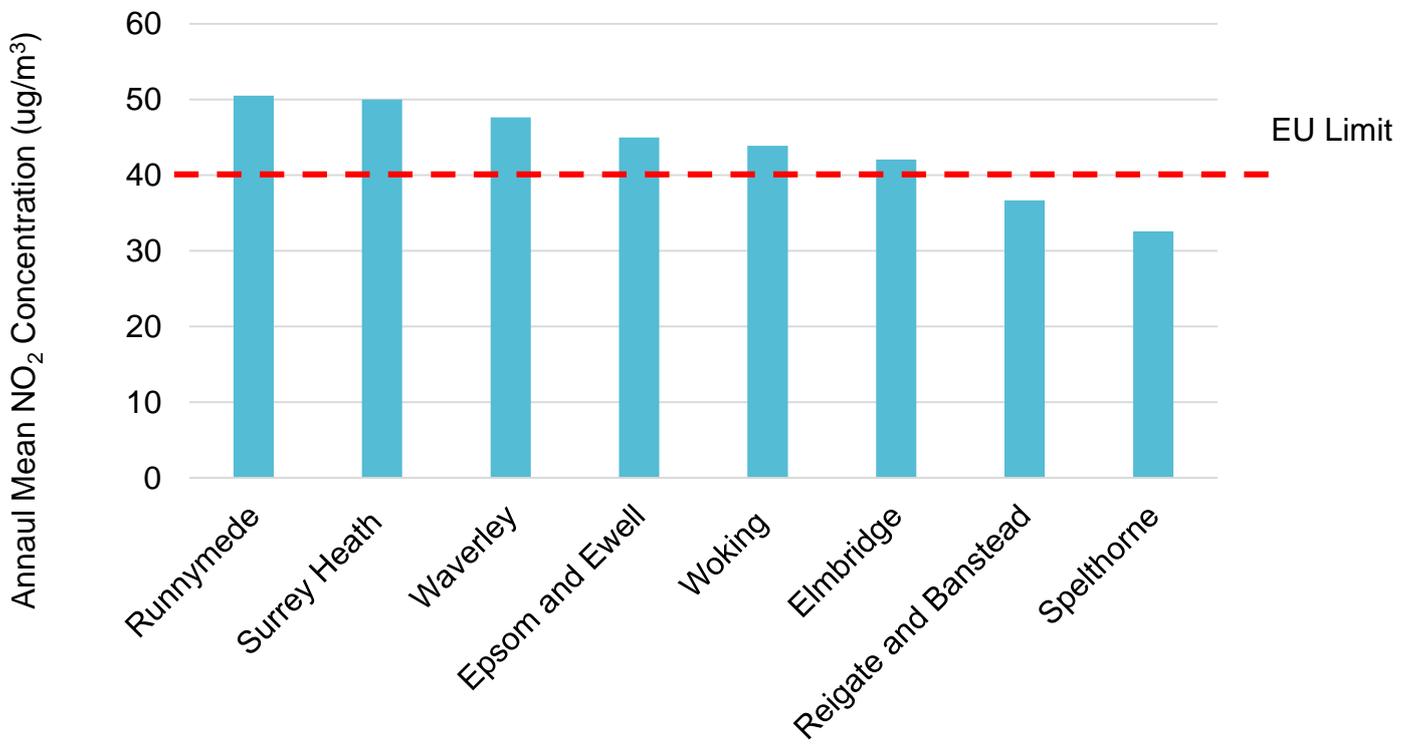
This map was produced by Notre Dame RC Secondary Girls' School, an all-girls' Roman Catholic comprehensive school situated in Elephant and Castle, London.



## Appendix 1.6 Teacher notes one: Continuum of Death

<p><b>BEE STINGS</b></p> <p>Typically, fewer than five people a year die because of bee or wasp stings in the UK.</p>	<p><b>AIR POLLUTION</b></p> <p>Up to 36,000 premature deaths a year are linked to several different types of indoor and outdoor air pollution in the UK.</p>
<p><b>LIGHTNING</b></p> <p>Typically, 30 to 60 people are struck by lightning each year in the UK, with an annual death toll of fewer than five.</p>	<p><b>ALCOHOL</b></p> <p>In the UK, alcohol poisoning and long-term alcohol abuse killed 6,592 people in 2015.</p>
<p><b>SMOKING</b></p> <p>Smoking is responsible for 96,000 deaths a year in the UK, mainly from cancer, respiratory diseases and circulatory diseases.</p>	<p><b>DROWNING</b></p> <p>Around 200 people accidentally drown each year in the UK, with around 30 of those deaths happening in the bath.</p>
<p><b>TRAFFIC ACCIDENTS</b></p> <p>1,775 people died because of traffic accidents in the UK in 2015.</p>	<p><b>ILLEGAL DRUGS</b></p> <p>Narcotics or hallucinogens killed 1,605 people in the UK in 2015.</p>
<p><b>SELFIES</b></p> <p>Zero deaths in the UK were caused by selfies. However, there were 28 selfie-related deaths worldwide in 2015. That's 20 more than deaths by sharks!</p>	<p><b>OBESITY</b></p> <p>In the UK, obesity and complications arising from obesity were responsible for 34,100 deaths in 2015.</p>

## Appendix 1.7a NO<sub>2</sub> Emission Levels in Surrey



## Appendix 1.7b Teachers notes two: Using NO<sub>2</sub> Diffusion Tubes

### What is an NO<sub>2</sub> diffusion tube?

Diffusion tubes can be used to measure the average concentration of NO<sub>2</sub> in the local atmosphere. The diffusion tube has a steel mesh which is coated with a chemical and hidden under the grey cap. When gases pass over this mesh NO<sub>2</sub> reacts with this chemical. This chemical change tells us the average concentration of NO<sub>2</sub> in the air.

### How to use an NO<sub>2</sub> diffusion tube

1. Choose a site
  - Minimise the risk of the tubes going missing by using locations that you know (i.e. your house or neighbours' wall) or by placing them up to two metres high.
  - Make sure the site is not covered by trees, bushes or other plants.
  - Do not choose a doorway or hole in a wall because air will not be flowing freely enough.
2. Deploy the diffusion tubes
  - Add a barcode label to the tube (not the grip)
  - Add the corresponding one onto the monitoring sheet
  - Add information to the monitoring sheet about location (e.g. bus stop, Battersea Bridge Road), start time and any other information such as height of site and site characteristics (e.g. close to building works).
  - Remove the white cap and put it into your sampling bag. Don't lose the white cap: keep it safe! You need to replace it at the end of experiment.
  - Fix the tube to the wall: insert the tube into black plastic wall mounts, peel off the red patch and stick to the wall surface. If needed, you can use additional string or ties.
3. Collect the tube after two weeks
  - Put the white cap back on the tube and place it back into the bag.
  - Record the date and time that the cap is replaced.
  - Record details of tube condition (Dirt? Insects? Dislodged?).
  - Has anything changed in the area?
4. Send Tubes to laboratory for analysis
  - It typically takes 10 working days for results to be returned.

See Appendix 2.4 for more detailed instruction on using the diffusion tubes.

### NO<sub>2</sub> Monitoring Information and Timings

DEFRA's Local Authority Air Quality Support programme includes a monitoring and data entry system for the use of UK Local Authorities using NO<sub>2</sub> diffusion tubes for Local Air Quality Monitoring purposes. You can use this system to look at the public recordings of diffusion tubes in your Local Authority and even coordinate the timings of your data collection with the LA's.

<http://laqm.defra.gov.uk/diffusion-tubes/data-entry.html>

# Appendix 2 Citizen Science Methods

## Appendix 2.1.1 Cleaner Air 4 Schools Baseline Survey

Name																				
School																				
Transport																				
How far do you live from school?(please circle)																				
<div style="display: flex; justify-content: space-between; align-items: flex-start;"> <span>&lt;0.5 mile</span> <span>0.5-1 mile</span> <span>1-1.5 mile</span> <span>+1.5mile</span> <span>Don't know</span> <span>Not in this borough</span> </div> <div style="text-align: right; margin-top: 5px;">Please specify _____</div>																				
Travel Method																				
How do you <u>usually</u> travel to school										How would you like to travel to school										
Current Travel Method										Desired Travel Method										
Park & Stride										Park & Stride										
Car Share										Car Share										
Car										Car										
Rail / Overground										Rail / Overground										
Tube										Tube										
Public Bus										Public Bus										
School Bus/Taxi										School Bus/Taxi										
Cycle										Cycle										
Scooter										Scooter										
Walking										Walking										

How much do you agree or disagree with the following statements (please circle)

I know a lot about pollution and air quality  
Strongly disagree      Disagree      Neither      Agree      Strongly Agree

I am aware of the health impacts of air pollution  
Strongly disagree      Disagree      Neither      Agree      Strongly Agree

I am concerned about the health impacts of air pollution  
Strongly disagree      Disagree      Neither      Agree      Strongly Agree

I am aware of actions I can take to reduce my exposure of air pollution  
Strongly disagree      Disagree      Neither      Agree      Strongly Agree

I am aware of how my actions contribute to air pollution  
Strongly disagree      Disagree      Neither      Agree      Strongly Agree

## Appendix 2.1.2 Cleaner Air 4 Schools Follow Up Survey

Please provide your feedback about the project

How much do you agree or disagree with the following statements (please circle)				
The pace of the sessions was about right				
Strongly disagree	Disagree	Neither	Agree	Strongly Agree
The sessions were pitched at the right level for me to understand				
Strongly disagree	Disagree	Neither	Agree	Strongly Agree
I would recommend this project to other schools				
Strongly disagree	Disagree	Neither	Agree	Strongly Agree

What would you change about the sessions / how would you make them better?

What would you like to see change in terms of air quality / your school?

As a result of the project, how much do you agree or disagree with the following statements (please circle)

I have a better understanding of air quality issues

Strongly disagree      Disagree      Neither      Agree      Strongly Agree

I have an increased understanding of the health impacts of air quality

Strongly disagree      Disagree      Neither      Agree      Strongly Agree

Increased confidence to measure and identify air pollution

Strongly disagree      Disagree      Neither      Agree      Strongly Agree

Increased confidence in creating & delivering a campaign

Strongly disagree      Disagree      Neither      Agree      Strongly Agree

Increased skills & confidence to undertake a scientific enquiry

Strongly disagree      Disagree      Neither      Agree      Strongly Agree



Please provide a comment about the project

## Appendix 2.3.1 Lichen Monitoring Guide

Date: \_\_\_\_\_ Time: \_\_\_\_\_ Location: \_\_\_\_\_

Weather: \_\_\_\_\_

Names of participants: \_\_\_\_\_

### About Lichens

Lichen is made up of two organisms living together: a fungus and an alga. Lichens usually attach themselves to trees, but they can also be found on other surfaces like pavement. So what kind of air do they like?

- Nitrogen-sensitive lichens only live in clean air
- Nitrogen-loving lichens can live in dirty air
- Some lichens are not affected by air quality and can live anywhere!

You can work out if the air is polluted by looking at the types of lichen growing. Different lichen species display different shapes and colours. The pictures of lichens in Table 6 and magnifying glasses will help you to identify them.

Resources from OPAL: <https://www.opalexplornature.org/lichen-identification-guide>

### How much area does a lichen cover?

1. small: less than  $\frac{1}{4}$  A4 sheet
2. medium:  $\frac{1}{4}$  up to one A4 sheet
3. large: more than one A4 sheet

## Appendix 2.3.2 Lichen Identification Sheet

Chosen Area: \_\_\_\_\_

Date: \_\_\_\_\_ Time: \_\_\_\_\_ Location: \_\_\_\_\_

Weather: \_\_\_\_\_

Names of champions/ participants:

\_\_\_\_\_

A lichen is made up of two organisms living together: a fungus and an alga. Lichens usually attach themselves to trees, but they can also be found on other surfaces. So what kind of air do they like?

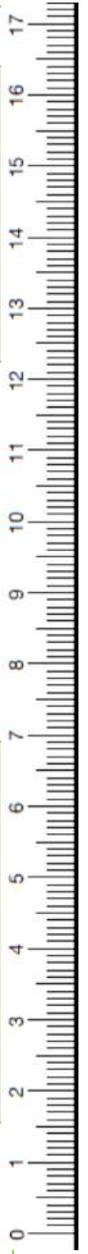
- Nitrogen-sensitive lichens only live in clean air
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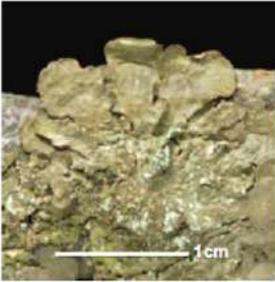
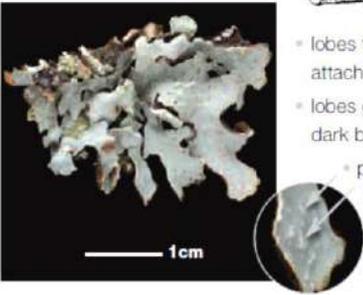
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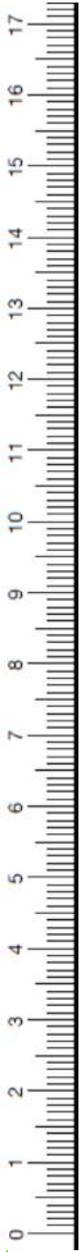
## Nitrogen-sensitive lichens: Clean Air

Nitrogen-sensitive lichens: Clean Air		How much area does it cover? (A) small: less than ¼ A4 sheet (B) medium: ¼ up to one A4 sheet (C) large: more than one A4 sheet	How many trees with this lichen did you see?
Nitrogen-sensitive	<p><b>1. Usnea</b></p>   <ul style="list-style-type: none"> <li>• branches thread-like</li> <li>• grey-green all round</li> </ul>	<p><i>I have other names: “Tree moss” and “beard moss”</i></p>	
Nitrogen-sensitive	<p><b>2. Evernia</b></p>   <ul style="list-style-type: none"> <li>• lobes flattened, strap-like</li> <li>• grey-green on top, white below</li> </ul>		<p><i>You can call me “oak moss”! I can be used to make perfumes.</i></p>
Nitrogen-sensitive	<p><b>3. Hypogymnia</b></p>   <ul style="list-style-type: none"> <li>• lobes greyish on top, pale brown below</li> <li>• lobe ends often become powdery</li> <li>• lobes puffed up and hollow</li> </ul>		<p><i>My nickname is “tube lichen”!</i></p>

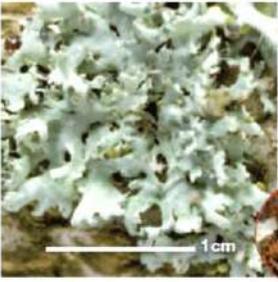


## Intermediate lichens: Grow Anywhere

Intermediate lichens: Grow Anywhere		
Can you find these lichens?	How much area does it cover? (A) small: less than ¼ A4 sheet (B) medium: ¼ up to one A4 sheet (C) large: more than one A4 sheet	How many trees with this lichen did you see?
<p style="writing-mode: vertical-rl; transform: rotate(180deg);"><b>Intermediate</b></p> <div style="border: 1px solid gray; padding: 5px;"> <p><b>4. Melanelixia</b></p>   <ul style="list-style-type: none"> <li>• dull brown lobes, closely attached to the bark</li> <li>• paler areas show when surface is rubbed</li> </ul> </div>	<p><i>Some people also call me “camouflage lichen”</i></p>	
<p style="writing-mode: vertical-rl; transform: rotate(180deg);"><b>Intermediate</b></p> <div style="border: 1px solid gray; padding: 5px;"> <p><b>5. Flavoparmelia</b></p>   <ul style="list-style-type: none"> <li>• broad, apple-green lobes</li> <li>• wrinkled surface on which powdery spots may develop</li> </ul> </div>	<p><i>I am found in woodland but becoming common in towns!</i></p>	
<p style="writing-mode: vertical-rl; transform: rotate(180deg);"><b>Intermediate</b></p> <div style="border: 1px solid gray; padding: 5px;"> <p><b>6. Parmelia</b></p>   <ul style="list-style-type: none"> <li>• lobes thin, loosely attached to the bark</li> <li>• lobes grey on top, dark brown below</li> <li>• pattern of white lines on the surface</li> </ul> </div>	<p><i>I am pretty hardy! Bird droppings do not kill me!</i></p>	



## Nitrogen-loving lichens: Polluted Air

Can you find these lichens?	How much area does it cover? (A) small: less than ¼ A4 sheet (B) medium: ¼ up to one A4 sheet (C) large: more than one A4 sheet	How many trees with this lichen did you see?
<p style="writing-mode: vertical-rl; transform: rotate(180deg);"><b>Nitrogen-loving</b></p> <p><b>7. Leafy Xanthoria</b></p>  <ul style="list-style-type: none"> <li>• lobes broad and spreading</li> <li>• lobes yellow/orange to greenish yellow</li> <li>• orange fruiting bodies often present</li> </ul>   	<p><i>We have different colours from orange to green!</i></p>	
<p style="writing-mode: vertical-rl; transform: rotate(180deg);"><b>Nitrogen-loving</b></p> <p><b>8. Cushion Xanthoria</b></p>  <ul style="list-style-type: none"> <li>• lobes small and clustered</li> <li>• lobes yellow to green-grey</li> <li>• orange fruiting bodies usually present</li> </ul>  		
<p style="writing-mode: vertical-rl; transform: rotate(180deg);"><b>Nitrogen-loving</b></p> <p><b>9. Physcia</b></p>  <ul style="list-style-type: none"> <li>• lobes grey on top, whitish below</li> <li>• lobe ends raised up becoming powdery</li> <li>• black-tipped whiskers on the lobe edges</li> </ul>  	<p><i>I am popular in big cities and major roads.</i></p>	

## Appendix 2.4. Instructions on Measuring Nitrogen Dioxide (NO<sub>2</sub>) with Diffusion tubes

- **What is an NO<sub>2</sub> diffusion tube?**

Diffusion tubes can be used to measure the average concentration of NO<sub>2</sub> in the local atmosphere. The diffusion tube has a steel mesh which is coated with a chemical and hidden under the grey cap. When gases pass over this mesh NO<sub>2</sub> reacts with this chemical. This chemical change tells us the average concentration of NO<sub>2</sub> in the air.

- **Why we measure NO<sub>2</sub>**

NO<sub>2</sub> is a reddish-brown gas that damages our health. The majority of this pollutant is produced by road transport, and the concentration of NO<sub>2</sub> is increasing in some areas.

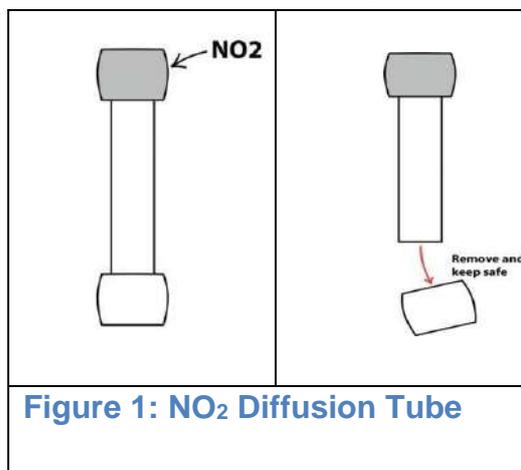


Figure 1: NO<sub>2</sub> Diffusion Tube

- **How to use it?**

1. **Choose a site**

- Minimise the risk of the tubes going missing by using locations that you know (i.e. your house or neighbours' wall) or by placing them up to 2 meters high
- Make sure the site is not covered by trees, bushes or other plants
- Do not choose a doorway or hole in the wall because air will not be flowing freely enough there

2. **Label the tube**

- Add the barcode label to the tube (not the grip)
- Add information to sampling and exposure data (include postcode if you can)
- Keep it safe!

3. **Remove the white cap**

- Remove the white cap and put it into your sampling bag
- Don't lose the white cap! Keep it safe. You need to replace it at the end of the two-week study period

#### 4. Monitoring record

- Stick one of the bar code labels onto the tube, and the corresponding one onto the monitoring sheet
- Add information to the monitoring sheet about location (i.e. bus stop, Battersea Bridge Road), start time and any other information such as height of site and site characteristics (i.e. close to building works)

#### 5. Fix the tube to the wall

- Inset the tube into black plastic wall mounts
- Peel off the red patch and stick to the wall surface
- Additional string or ties may be used

#### 6. After two to four weeks: Collect the tube

- Put the white cap back on and place it back into the bag
- Record the date and time that the cap is replaced
- Record details of tube condition (Dirt? Insects? Dislodged?)
- Has anything changed in the area?

Figure 2: NO<sub>2</sub> Tube Fixing



## Appendix 2.5.1 Traffic Survey Record Sheet

Year and Class: \_\_\_\_\_ Date: \_\_\_\_\_

Location: \_\_\_\_\_ Time: \_\_\_\_\_

Type	Tally of transport seen in 15mins	Total number of vehicle seen in 15 mins
Car 		
Bus 		
Lorry 		
Van 		
Motorbike/Scooter 		
Bicycle 		
Walking 		

## Appendix 2.5.2 Idling Survey Instructions

### What is idling?

- When people leave their car engine running while they have stopped or parked, this is called 'idling'. A car is 'idling' if it has been left running for **over one minute** after stopping or parking
- Idling can cause pollution around school when parents pick up or drop off children. Their cars cough out dirty, smelly fumes. Yuck!

### How do we monitor idling?

- To work out if idling is causing pollution around your school, you can count the number of parents' cars outside your school that are idling.
- It's best to count parents' cars idling during the busy time in the morning before school starts and again in the afternoon when school ends. For example, if your school starts at 9:00 and ends at 3:30, you should do the survey from 8:30 - 9:00am and 3:15 - 3:45pm, because parents may come earlier to drop off or wait for their children.
- Choose to do your idling survey on a day when most pupils leave school around the same time. Your teacher will send you, in groups, to a location beside the road near your school where parents drop off their children.

### Instructions:

Fill out the form on the next page with your name, the date, and your location. You will be counting cars in two 15-minute blocks. Follow the steps below so we can compare everyone's results later.

1. In a group of three, choose who you will be:
  - Champion 1 **Observer**: spot and identify parents' cars
  - Champion 2 **Timer**: time how long parents' cars are left idling
  - Champion 3 **Recorder**: record the number of cars idling and not idling
2. What is the time? Write the time in the column 'Start Time' when you start (e.g. 8:30am). Write the time when you stop counting cars in 'End Time' column? The **Timer** should make sure that you stop counting cars after 15 minutes.
3. The **Observer** looks for parents' cars that are idling and not idling and tells the **Timer**.
4. The **Timer** uses a stop watch to time if cars have been idling for at least **one minute**.
5. The **Recorder** puts one dash in the column 'Number of cars idling' every time the **Observer** and the **Timer** find an idling car, and one dash in the column 'Number of cars not idling' every time the **Observer** spots a parked car that is not idling.
6. At the end of 15 minutes, the **Timer** tells the **Observer** to stop counting and the **Recorder** writes the finish time in the column 'End Time' (e.g. 8:45 am). Add up the number of cars idling and not idling and record this in the 'total' column.
7. After a 1-minute break, you can swap jobs. Repeat steps 1-6 and record your findings in the second row.
8. When you finish counting cars for the second time, add up all the cars idling and put this number in the 'total, column on the bottom row. Add up all the cars not idling and put this number in the 'total' column on the bottom row.
9. Repeat steps 1-8 again in the afternoon.
10. At the end of the day, give your record form to your teacher. Do you think idling is a problem at your school? If yes, what can you do about it?

### Fact!

An anti-idling campaign was launched in Surrey, with banners placed around Reigate level crossing. Pollution levels near the level crossing were seen to have fallen.

Congratulations! You've completed your idling survey.

## Appendix 2.5.3 Idling Survey Record Form

School: \_\_\_\_\_ Date: \_\_\_\_\_ Location/ street: \_\_\_\_\_

Supervisor: \_\_\_\_\_ Observer: \_\_\_\_\_ Timer: \_\_\_\_\_ Recorder: \_\_\_\_\_

Morning AM

Session	Start time	End time	Number of cars idling	Total	Number of cars NOT idling	Total
Morning Session 1						
Morning Session 2						
Total number of			cars idling		cars not idling	

Afternoon PM

Session	Start time	End time	Number of cars idling	Total	Number of cars NOT idling	Total
Afternoon Session 1						
Afternoon Session 2						
Total number of			cars idling		cars not idling	

## Appendix 3 Example of Community Action Planning

How to create change ...

### Through health and wellbeing boards

Include air quality to inform their strategic planning and decision making:

- Implement NICE guidance on walking and cycling (ph41)
- Monitor the impact of air quality
- Bike share schemes and expansion

Let people know the risks and effects of air pollution:

- Distribute leaflets about air pollution risks in doctors' surgeries and other community hubs
- Doctors can explain the effect of air pollution to vulnerable people (young people, people with existing respiratory problems such as asthma) and how they can reduce their risk by letting them know the most polluted routes
- Promote text alert system to provide live pollution warnings to those most at risk

### Through planning

Work with your local council to increase guidance for developers on methods to construct Air quality neutral developments including:

- Public transport connections within walking distance
- Avoid creating an urban canyon effect, a street with high buildings either side
- Walking friendly design with well lit, safe pavements
- Buffer zone between roads and living spaces
- Cycle storage
- Low NO<sub>2</sub> heating

The Community Infrastructure Levies and local development framework could be used to fund infrastructure which improves air quality:

- Improve / expand cycle routes (more cycle routes / better maintained)
- No idling' signs e.g. around town centres and schools
- '20 is plenty' road signs across borough for a smoother journey
- Fund 'last mile carbon free' logistic centres

### With local council

- Ask bus companies to retrofit / replace oldest buses first with new low emission hybrid buses
- Enforce existing 'no idling' laws (after one minute of idling drivers are wasting money as well as polluting)
- For our schools:
  - Create safe walking routes for children along less polluted roads
  - Create walking buses to school
- For housing developments:
  - Support community energy developments with low NO<sub>x</sub> boilers

## **In your community**

### *Monitor*

- Continue monitoring air pollution to build a bigger data set using diffusion tubes, lichen studies and particle meters
- Become a lichen observer and set up a lichen study team to increase awareness and knowledge about local air quality

### *Organise*

- Create a car pool club in your community group or school
- Hold an event to raise awareness of the effects of air pollution and simple steps that people can take to reduce their exposure and emissions (See next page)
- Hold events with other communities and groups to form a network, making your voices louder and your evidence stronger
- Events such as walking and cycling to school/work week

### *Share*

- Hold an event to share your monitoring results with your community
- Talk to your family and friends about air pollution to increase awareness in the whole community
- Give out leaflets publicising the disadvantages (Higher NO<sub>2</sub> / PM emissions) of diesel engines

## Appendix 4: Useful links

### Introduction

Survey Monkey:	<a href="http://www.surveymonkey.com">www.surveymonkey.com</a>
DEFRA UK-AIR:	<a href="http://uk-air.defra.gov.uk/">uk-air.defra.gov.uk/</a> (provides air quality data from the past to the future air pollution forecasts. The site is also useful to check the latest air quality news.)
Surrey Air Quality Forecast:	<a href="https://uk-air.defra.gov.uk/forecasting/locations?q=Surrey">https://uk-air.defra.gov.uk/forecasting/locations?q=Surrey</a> (contains current air quality information and forecasts of the air quality in Surrey).
UK national air quality objectives (DEFRA):	<a href="http://uk-air.defra.gov.uk/assets/documents/National_air_quality_objectives.pdf">uk-air.defra.gov.uk/assets/documents/National_air_quality_objectives.pdf</a>
Clean Air Day:	<a href="https://www.cleanairstay.org.uk/">https://www.cleanairstay.org.uk/</a> (Information on Clean Air Day and how you can get involved).

### Investigation

Lichen observation The Open Air Laboratories (OPAL) network:	<a href="https://www.opalexplornature.org/lichen-identification-guide">https://www.opalexplornature.org/lichen-identification-guide</a> (Lichen and air survey, guide and quiz)
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### Analysis

London Air Quality Network:	<a href="http://www.londonair.org.uk/LondonAir/guide/Soundslides/HealthEffects/HealthEffectsVideo.aspx">www.londonair.org.uk/LondonAir/guide/Soundslides/HealthEffects/HealthEffectsVideo.aspx</a> (A 3 minute video on the impacts of air pollution can be found here)
Air Quality Now:	<a href="http://www.airqualitynow.eu/">www.airqualitynow.eu/</a>

### Taking Action

Walkit:	<a href="http://walkit.com/">walkit.com/</a> (users can create journey planner for walking.). This is only for London but is provided as an example for greener routes to school.
Sustrans:	<a href="http://www.sustrans.org.uk/">www.sustrans.org.uk/</a> (Information on how to 'change your travel' habits e.g. cycling, reducing car use.)
Travel Plan Advice STARS (TfL):	<a href="http://www.staccreditation.org.uk/school/yta.php">www.staccreditation.org.uk/school/yta.php</a> (Youth Travel Ambassador Toolkits can be downloaded from)

Reducing Emissions from School Buildings Carbon Trust:	<a href="https://www.carbontrust.com/resources/guides/sector-based-advice/schools/">https://www.carbontrust.com/resources/guides/sector-based-advice/schools/</a> (Toolkit for school energy efficiency can be found on the main website of Carbon Trust).
Reducing Exposure to Pollution in School TfL:	<a href="http://www.tfl.gov.uk/modes/driving/low-emission-zone">www.tfl.gov.uk/modes/driving/low-emission-zone</a> (Information on the Low Emission Zone)
Healthy Surrey Air Quality Advice:	<a href="https://www.healthysurrey.org.uk/your-health/seasonal-advice/air-quality">https://www.healthysurrey.org.uk/your-health/seasonal-advice/air-quality</a> (Information on steps to improving quality)
Surrey airAlert:	<a href="http://www.airalert.info/Surrey/">http://www.airalert.info/Surrey/</a> (Sign up for alerts air quality alerts to be notified when air pollution is particularly high).

## Appendix 5 Suppliers of Nitrogen Dioxide Diffusion Tubes

Defra and the Devolved Administrations advise that diffusion tubes used for Air Quality Monitoring should be obtained from laboratories that have demonstrated satisfactory performance in the AIR PT scheme. For the latest results see <http://lagm.defra.gov.uk/diffusion-tubes/qa-qc-framework.html>

Aberdeen Scientific Services Laboratory  
Aberdeen City Council  
Housing and Environment  
Old Aberdeen House Dunbar Street  
Aberdeen, AB24 3UJ  
Email: [ASSL@aberdeencity.gov.uk](mailto:ASSL@aberdeencity.gov.uk)  
Telephone: +44 (0)1224 491648

Edinburgh Scientific Services  
4 Marine Esplanade,  
Edinburgh, EH6 7LU  
Email: [scientific.services@edinburgh.gov.uk](mailto:scientific.services@edinburgh.gov.uk)  
Telephone: +44 (0)131 555 7980

Environmental Services Group, Didcot  
Unit 12 Moorbrook  
Southmead Industrial Park  
Didcot  
Oxfordshire, OX11 7HP  
Contact: Mr P.Duncan  
Email: [sales@esg.co.uk](mailto:sales@esg.co.uk)  
Telephone: +44 (0)1235 750730

Glasgow Scientific Services  
Customer Care Team  
Glasgow City Council  
City Chambers  
Glasgow, G2 1DU  
Email: [GSS@glasgow.gov.uk](mailto:GSS@glasgow.gov.uk)  
Telephone: +44 (0)141 276 0610

Gradko International  
St. Martins House  
77 Wales Street  
Winchester  
Hampshire, SO23 0RH  
Email: [diffusion@gradko.com](mailto:diffusion@gradko.com)  
Telephone: +44 (0) 1962 860331

Kirklees MBC  
Kirklees Environmental Services  
Scientific Services  
West Riding House  
9 Manchester Road  
Huddersfield, HD1 3HH  
Tel: 01484 226477

Lambeth Scientific Services  
Chessington Business Centre,  
Cox Lane,  
Chessington,  
Surrey, KT9 1SD  
Email: [enquiries@scientificservices.co.uk](mailto:enquiries@scientificservices.co.uk)  
Telephone: +44 (0)20 8391 4509

Milton Keynes Council  
Civic Offices  
1 Saxon Gate East  
Central Milton Keynes, MK9 3EJ  
Email: [customerservices@miltonkeynes.gov.uk](mailto:customerservices@miltonkeynes.gov.uk)  
Telephone: +44 (0)1908 252398

Northampton Borough Council  
Guildhall,  
St. Giles Square,  
Northampton, NN1 1DE  
Telephone: +44 (0)300 330 7000

Somerset Scientific Services  
Unit 2A, Westpark  
26, Chelston,  
Wellington,  
Somerset, TA21 9AD  
Email: [somersetscientific@somerset.gov.uk](mailto:somersetscientific@somerset.gov.uk)  
Telephone: +44 (0)300 123 2224

Staffordshire County Council  
1 Staffordshire Place,  
Stafford, ST16 2DH  
Email: [contactus@staffordshire.gov.uk](mailto:contactus@staffordshire.gov.uk)  
Telephone: +44 (0)300 111 8000

Tayside Scientific Services  
James Lindsay Place,  
Dundee Technopole,  
Dundee, DD1 5JJ  
Email: [jane.couper@dundeecity.gov.uk](mailto:jane.couper@dundeecity.gov.uk)  
Telephone: +44 (0)1382 307170

West Yorkshire Analytical Services  
PO Box 11,  
Nepshaw Lane South  
Morley  
Leeds, LS27 0UQ  
Email: [analytical@wyjs.org.uk](mailto:analytical@wyjs.org.uk)  
Telephone: +44 (0)113 393 971

