



Why Is There Such A High Level Of Nitrogen Dioxide at the Entrance to Our School?

The King's Hospital School, Dublin, Ireland

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2. Abstract

We had the air quality in different places in our school tested and found that at the front entrance it was the worst for any school in Ireland. We looked into why this was and what we can do to help.

Our school entered into a project by GLOBE where they came and tested our air quality. When we got back the results we wanted to make a project to further understand the where and why of our poor air quality.

We took the results and made a coloured graph ranging from good air quality to bad standard. We ended up with three results. The air around the back pitches was average, the air around the back car park was a bit worse, with a rating of mediocre however, around the entrance at the front was where we got Ireland's worst result, with a rating of very bad.

In conclusion, we came up with three main reasons for the quality. The first was the M50 and N4 causing a lot of nitrogen oxide as many cars come by. The next was the bus stop about 50 yards from the front gate. The big buses make for a lot of fumes. The last reason was the speed bump at the gate. It is only a one-way road. It makes the cars stop and thus produce more nitrogen oxide with the stopping and starting.

We found out that making the front entrance a two-way system would help stop the situation to an extent. We also found more trees would help as they clear the air but they also make a physical barricade shielding the school.

Some of the keywords that are used in this paper are:

- NO₂
- Air Quality
- School Entrance
- Concentration

3. Research Questions

At the start of our project, we had four main big questions, they were:

- Why is there such a high level of NO₂ at the entrance to The King's Hospital?
- Why is the NO₂ concentration very high away from the main road?
- Why was our reading at the front gate the highest in the country?
- Looking at other schools, are there high NO₂ levels beside moving traffic?

We believed that these questions were of great importance because we had no idea why there was a very high level of Nitrogen Dioxide around our school, and we believed that we would find out the answer by answering these research questions.

4. Introduction and review of the literature

Last year, our school, The King's Hospital, Dublin, Ireland, took part in The GLOBE Air Quality campaign. The school agreed to have the air around the school tested for Nitrogen Dioxide (NO₂). Before this, we didn't know much about what the air around the school was made up of, so we were interested to learn more and were looking forward to what the results would show. While we were waiting for these results, we did a bit of background research on Nitrogen Dioxide.

NO₂ can inflame the lining of the lungs making respiratory diseases worse. It can also cause wheezing, coughing and bronchitis and increases the likelihood of developing respiratory diseases such as asthma.¹ We found that 1 in 10 children have asthma while 1 in 5 children experience asthma at some stage in their life² and we were, of course, concerned for their health and well-being. Unfortunately, there is clear evidence of health effects associated with short-term exposure to NO₂³ and we didn't want our school community to suffer any unnecessary respiratory issues, so, of course, we were concerned for their general welfare.

A total of 36 schools participated in the test. They were from all over Ireland and ranged from being located in rural areas to being in Dublin city centre. See Chart 1 for some of the information we were given about each school that took part. We are School Number 36

When we received the results from the Environmental Education Unit's analysis of Irish school's air quality testing, we were shocked to discover that our school had the highest Nitrogen Dioxide (NO₂) concentration in the country, with one reading of 46.17µg/m³ (described as Very Bad by the air quality scale. [Graph 3])

When we learned that we had some of the worst air quality in the country, our first reaction was shock and confusion. But, we were eager to find out the cause of the problem.

At first glance, our school is in an ideal location. It is an 80-acre site on the banks of the River Liffey at Brooklawn in Palmerstown, Co Dublin.⁴ However, the school borders the M50 motorway and the N4 dual carriageway, which led us to think that maybe this was one of the reasons why we had such a high NO₂ concentration.

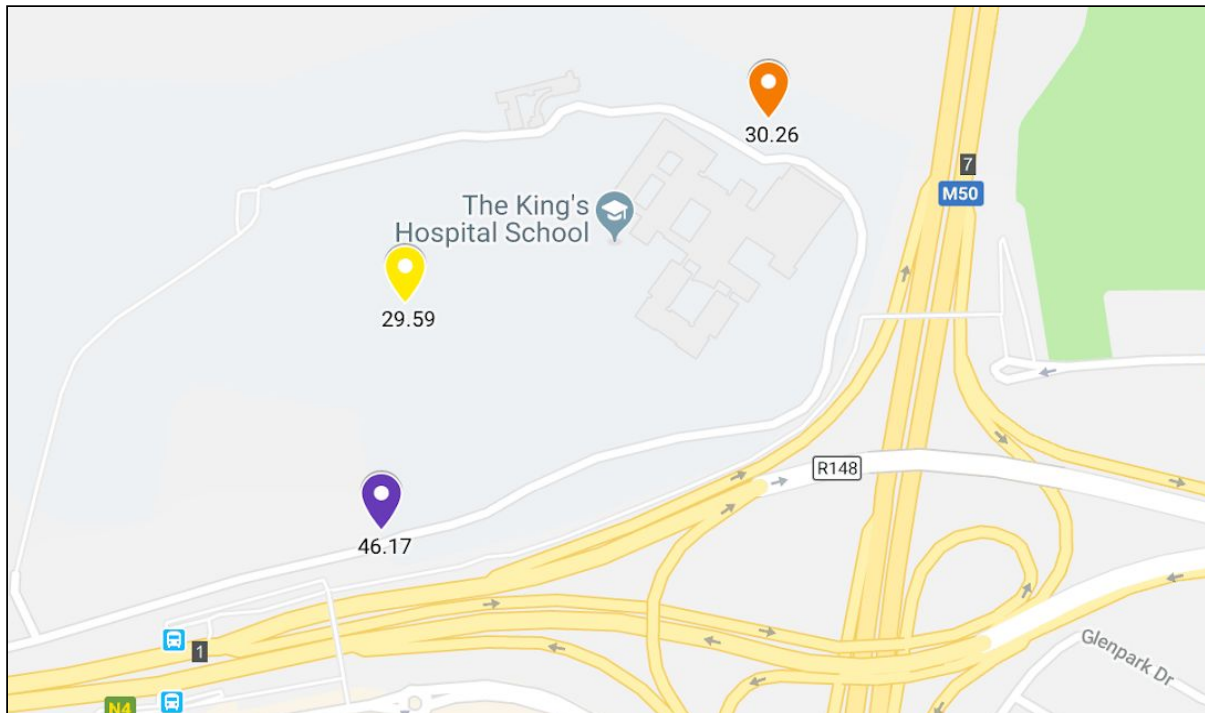
We decided to delve in deeper and we started asking some difficult questions that we didn't know the answers to.

Chart 1

School No.	No. of students	County	Location profile
2	311	Co. Offaly	Town 3,000-4,999
4	666	Co. Dublin	Suburban
5	825	Co. Cork	Suburban
7	681	Co. Mayo	Town > 10,000
8	444	Co. Dublin	Suburban
10	239	Co. Kilkenny	Town > 10,000
11	1054	Co. Cork	Town 5,000-9,999
12	679	Co. Dublin	Suburban
13	402	Co. Dublin	City
14	706	Co. Cavan	Rural
16	1288	Co. Dublin	Town > 10,000
17	157	Co. Monaghan	Town 5,000-9,999
18	711	Co. Westmeath	Town > 10,000
19	771	Co. Dublin	Suburban
21	0	Co. Dublin	City
22	389	Co. Galway	Town 1,500-2,999
23	705	Co. Donegal	Town 5,000-9,999
24	767	Co. Cork	Town 1,500-2,999
25	780	Co. Cork	Suburban
27	711	Co. Cork	Rural
28	601	Co. Mayo	Town > 10,000
29	30	Co. Donegal	Town 5,000-9,999
30	652	Co. Roscommon	Town 1,500-2,999
32	291	Co. Dublin	City
33	378	Co. Galway	Suburban
34	244	Co. Dublin	Suburban
35	713	Co. Dublin	Town 5,000-9,999
36	716	Co. Dublin	Suburban

5. Research Methods

Map 1



In Map 1, we can see the three locations where the air was tested. The location of the yellow pin is in the middle of the sports pitch, at the cricket pavilion. Here, the concentration was $29.59\mu\text{g}/\text{m}^3$, a rating of Average.

In order to get the results, GLOBE representatives went into our school and used some nitrogen dioxide sample tubes. After the testing was finished, our results were calculated in Gradko lab for about 4 weeks. We had a mentor from An Taisce (Sabrina Moore) who helped us along with our teacher to complete our investigation.

There were some GLOBE protocols like the age restriction as well a limited distance we could go out (100m) and still have our results accepted by GLOBE.

Graph 3

NO ₂ concentration ($\mu\text{g}/\text{m}^3$)	Description
50 +	Extremely bad
45 - 50	Very bad
40 to 45	Bad
35 - 40	Substandard
30 - 35	Mediocre
25 - 30	Average
20 - 25	Pretty good
15 to 20	Good
10 to 15	Very good
0-10	Excellent

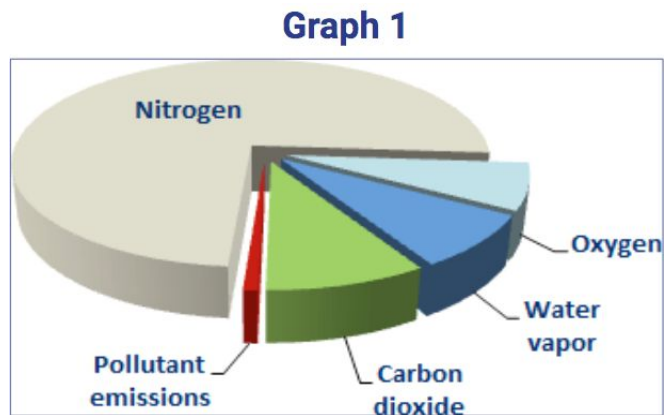
The location of the orange pin is in the back car park where students are dropped off and collected every day. Here the concentration was slightly higher at $30.26\mu\text{g}/\text{m}^3$, a rating of Mediocre.

The final pin, the purple one, is located at the entrance of the school. This is where the

highest reading was in the whole country, with a reading of $46.17\mu\text{g}/\text{m}^3$, a rating of Very Bad.

To help with all of these readings, we used the scale supplied by GLOBE. [Graph 3]

To answer the question 'Why is there such a high level of NO_2 at the entrance to The King's Hospital?', we had to find out what actually comes out of the exhaust of a car. We found that almost 75% of diesel car and bus emissions are NO_2 [Graph 1]⁵. Looking even further into the matter, we realised that there is also a busy bus stop situated 50 metres from the school gate.

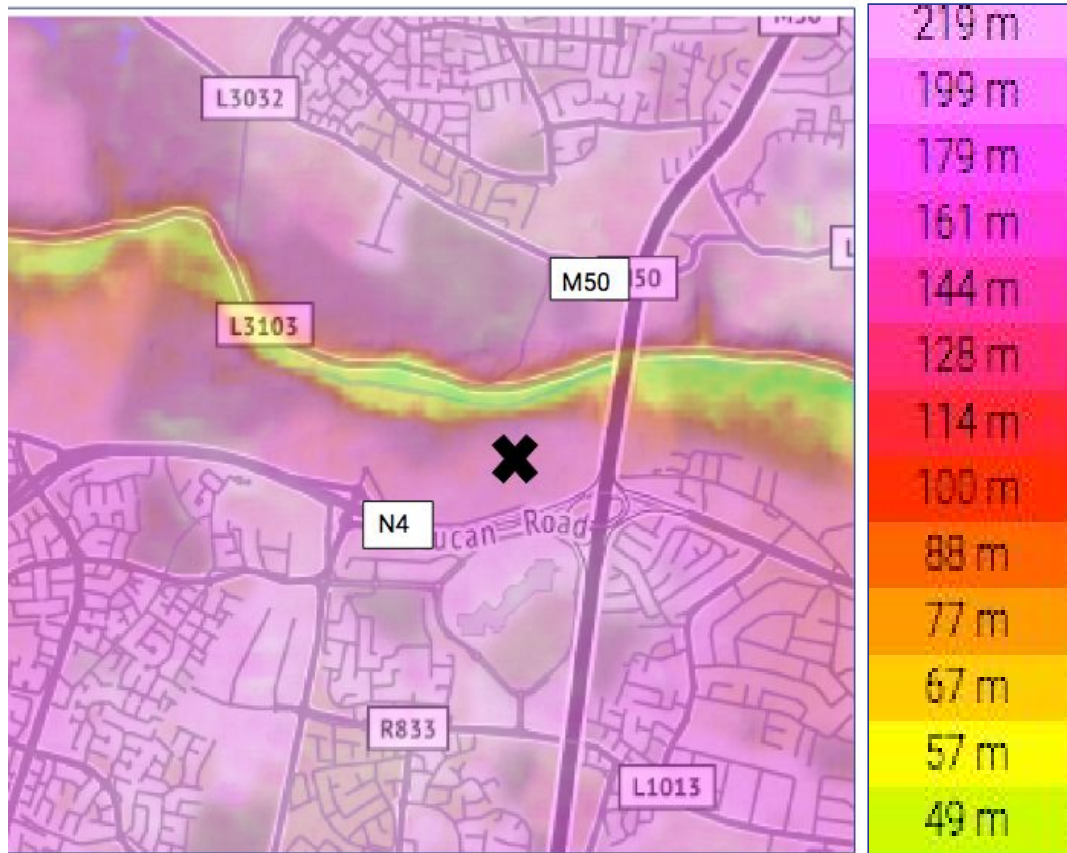


Without a doubt, the constant stopping and starting of these vehicles contributes hugely to the high readings around our school. We also took our results and compared them with some other school's results. Unfortunately, they looked quite bad.

To answer the question 'Why is the NO_2 concentration still very high away from the main road?' we first had to realise that the school is located on a minor road parallel to the N4 dual carriageway. We found that, during February, when daytime temperatures average 10°C in Dublin, NO_2 is far heavier than air. NO_2 has a density of $1450\text{ kg}/\text{m}^3$ whereas air at 10°C has a density of $1.225\text{ kg}/\text{m}^3$.⁶

Using a topographic map, we discovered that there is a downward slope from the main road to the school. This gradient means that the NO_2 from the nearby motorway and dual carriageway rolls down the hill and sits in the school grounds, like it's trapped at the bottom of a pit, thus making the NO_2 concentration high. [Map 2] The school is marked with an **X**.

Map 2



6. Results

We discovered that, for most vehicles, idling (the act of keeping an engine running slowly while the car is stationary) for more than 10 seconds releases more CO₂ than stopping and restarting your car. However, NO₂ emissions are higher from stopping and starting rather than idling.

Photo 1



At the entrance to The King's Hospital, the gate is only wide enough to allow one car to go through at a time. [Photo 1] There are also 2 speed bumps at the entrance which further slow down traffic passing through the gate. As a result of this, people stop their cars while waiting for other cars to pass through the gate. This cycle of cars stopping and starting their engines reflects the amount of NO₂ being released into the air.

This answers the question of why our NO₂ reading at the front gate is the highest in the country.

After analysing the nationwide results, we found that in almost every school across the country, NO₂ concentration is higher beside moving traffic compared to a sheltered area eg. a location just outside the school building. [Graph 2]

We used Graph 3 to help us analyse the data which can be seen on the vertical axis on Graph 2.

Graph 2

Difference in Concentration Between Locations Around the Schools



Graph 3

NO ₂ concentration (µg/m3)	Description
50 +	Extremely bad
45 - 50	Very bad
40 to 45	Bad
35 - 40	Substandard
30 - 35	Mediocre
25 - 30	Average
20 - 25	Pretty good
15 to 20	Good
10 to 15	Very good
0-10	Excellent

7. Discussion

After analysing our results, we believe the reason The King's Hospital has the highest reading in the country is that:

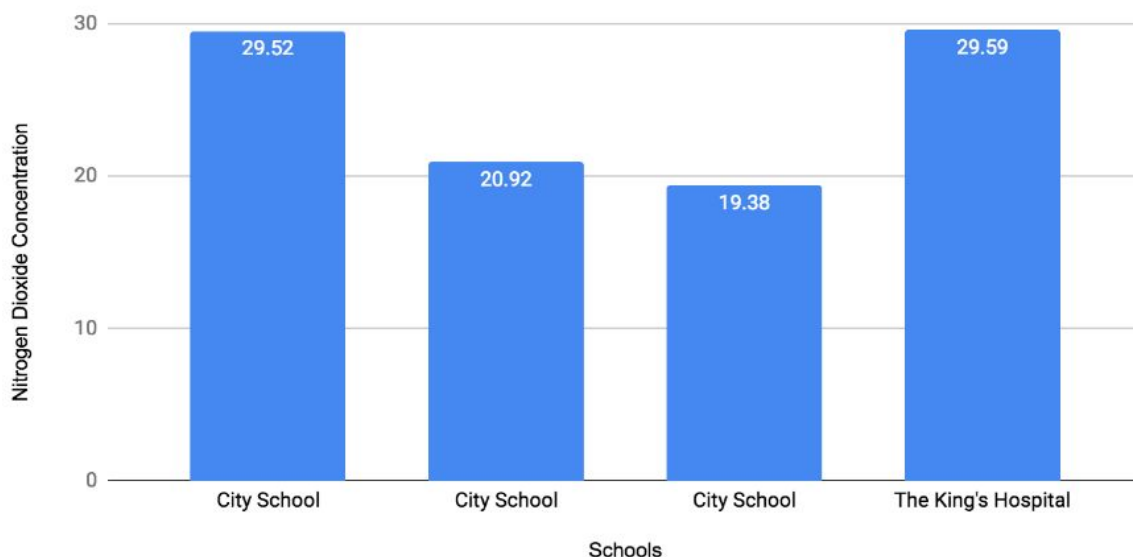
- A. Cars must stop at the front gate
- B. It is located beside two of the busiest roads in the country
- C. It is close to a commuter bus stop
- D. It sits at the bottom of a slope

The King's Hospital's results for NO₂ levels at moving traffic is higher than the other three schools located near Dublin city. [Graph 4]

Of course, if the test had taken place during a different time or was to be repeated, the results may have been different. Nevertheless, they would have still been pretty high because of the reasons we have outlined above.

Graph 4

A Comparison of Air Quality between the schools located near Dublin City



Beginning the project, we had a slight feeling that the concentration would be pretty high, but I don't think we ever thought that they would be as high as they were. Doing this project really opened our eyes to how location and slope can affect gas concentration.

8. Conclusion

- From our research we have discovered that NO₂ has a much higher concentration beside the entrance to the school because cars frequently stop and start here, producing emissions.
- To reduce the amount of NO₂ being emitted at the gate of the school we could remove the gate or make it wide enough to allow cars coming from each direction to pass each other.
This would eliminate the need for cars to have to stop at the gate, reducing the amount of negative gases being released into the air.
- To expand on this project we would consider testing other gases that are found in the air like carbon or sulfur oxides.
- We would also be interested to find out the time of day of peak NO₂ emissions, and is it linked to school peak traffic times and/or rush hour?
- We would also like to retest for NO₂ to see if the results are similar.
- We would consider informing the school body about the results and encourage them to walk, cycle, carpool or take the bus.
- We would also like to research trees and other shrubs that can take NO₂ out of the air. We think it would be a good idea to plant many of these trees on the boundary of the school.

9. Bibliography/citations

¹<https://www.environment.gov.au/protection/publications/factsheet-nitrogen-dioxide-no2>

² <https://www.asthma.ie/get-help/resources/facts-figures-asthma>

³ <https://bmjopen.bmj.com/content/5/5/e006946>

⁴ https://www.kingshospital.ie/About_us

⁵ https://dieselnet.com/tech/emi_intro.php

⁶<https://irishweatheronline.wordpress.com/2015/09/26/irish-weather-onlines-a-z-of-weather-terms/>

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