

Air Pollution in Cork City

2011 Report

(For monitoring results generated in 2010)

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Executive Summary

This report describes air quality in Cork City through an assessment of the monitoring data generated by Cork City Council for the calendar year 2010. The pollutants are generated through fuel combustion in space heating, traffic, electricity generation and industry. They are the pollutants present in significant amounts in the air that could affect the well being of the city inhabitants and they are the pollutants chosen in other European cities to describe air quality.

Monitoring data for ozone, nitrogen oxides, carbon monoxide and sulphur dioxide is accessed by the EPA through a modem link from our monitoring station. This allows them to issue public warnings should any incident of high ozone occur and to comply with EU Directives.

Standards and Health Effects

The standards that have been set by international bodies are part of a practical attainment strategy to progressively reduce air pollution and are not final ends or levels below which there is no effect. Standards have been revised and reduced over the years. The EU Directives in many instances specify limit attainment dates: for instance, the PM10 limit is to be reduced to one level by 2005 and to a lower level by 2010.

The American Cancer Society declares that no level of air pollution is safe. The concentration of any air pollutant should be kept as low as is practically possible. The different air pollution parameters have different effects and mixtures of them may have an effect more than additive (synergy).

It is currently estimated that halving the fine particulate (PM10) concentrations alone in ambient air would increase average life expectancy by 1-11 months. For perspective purposes, not smoking tobacco would increase life expectancy on average by about seven years. The main health effects are increased risk of heart ailments, asthmatic attacks and lung cancer.

In Cork, average levels of particulates range 16-22 ug/m³ and this is on the low side compared to other European cities but there is no safe level. The background levels in the UK are about 20 ug/m³ and 28 ug/m³ for roadside sites.

Reduction of Air Pollution

The main instrument for change is at EU level, regulating the emissions from motor industry, other sectors of industry and setting ambient levels. There has been some disappointment that the reduction in air pollutant levels has not been as great as expected; one of the reasons may be due consumer choice favouring larger diesel vehicles.

National government legislation and tax incentives can be very effective as seen in the past for the reduction of smoke and lead in this country.

At a local level, strategies that help to reduce the number and length of car journeys, avoid urban sprawl, and promote alternatives can be effective. Vehicles, especially older polluting ones, should be discouraged from the City centres. Road pricing is being considered in the UK as a means to avoid congestion and reduce car journeys. Taxation incentives could encourage such policies and tolls or congestion charges. Narrow street canyons where there is poor dispersion of air pollution should be avoided. Convenient communities where work, home, schools and shops are close together rather than being widely separated in zones could be encouraged along with clean efficient public transport, cycle and pedestrian friendly areas.

Space heating is also a major contributor to air pollution. Better building design, insulation and greener heating strategies are required. Community heating schemes should be reconsidered.

Avoiding Air Pollution

People who experience difficulty with breathing during high pollution episodes should avoid vigorous outdoor activity especially during rush hours to reduce exposure to PM. It is generally better to exercise indoors in a clean dust free room. However indoor air pollution can at times reach higher levels than outdoor due to heating appliances, emissions from building products and from people. Sealing the home to conserve heat serves to contain pollutants.

Compliance with Standards

While there is no safe level of air pollution, the following is the situation regarding compliance with EU Standards.

There appeared to be a small decreasing trend in concentrations in the last decade except for the last two winters that featured intense cold periods that increased emissions into poor dispersion conditions.

(1) PM 10 and PM 2.5 (Particulate Matter less than 10 and 2.5 microns). Particulates of this size penetrate more deeply into the lungs and have more effect on health. The results indicate slight non compliance for PM10 and compliance for PM2.5. The severe winter snaps are the likely cause. There were also problems with the instrument during the summer of 2010.

(2) Sulphur dioxide levels were always quite low in Cork. Sulphur is a contaminant in most types of fuel. Sulphur dioxide affects the lungs and corrodes materials. Results indicate compliance at about 10% of the limit. There has been an increase in the last two years.

(3) Nitrogen dioxide arises from air being used as an oxidant in the high temperature combustion of fuel in space heating and traffic. It affects lungs, plants and buildings. Average values are about 85% of the mean limit for health protection but that for vegetation is exceeded. There has been an increase in the last two years up from about 75% to 85% of the limit.

(4) Nitric oxide has no ambient standard because it is an intermediate in the oxidation sequence to nitrogen dioxide and has also less affect on the environment.

(5) Ozone levels were in compliance. There were no exceedances of the 8 hour running average while 25 are allowed.

Ozone levels can be strongly influenced by imported pollution and/or natural sunshine events.

Rural stations in Ireland have higher levels than urban stations because nitric oxide produced from fuel combustion reduces levels in cities. It is only in urban areas with extreme traffic densities and very high sunshine levels that a different series of reactions dominate to produce very high ozone levels. Ozone is an irritant to the respiratory system.

(6). Carbon monoxide levels are about 40% of the EU limit.

It arises from poor oxidation of fuel. It is toxic, reducing the supply of oxygen in the blood.

(7). Lead levels are about 1% of the EU limit.

This is a major decrease from the 1980's. It was a petrol additive to prevent "knock" and improve acceleration but now leaded petrol is no longer available.

It is a cumulative poison affecting the nervous system.

(8) The new continuous monitor, in operation since March 2000, indicated benzene levels to be about 10% of the standard. However the new monitor (installed since august 2008, indicates higher concentrations of benzene at about 27% of the

standard. Benzene derives mainly from traffic fuels. It is a carcinogen.
(10) Suspended particulates are no longer being monitored and have been replaced by the PM parameter. They reached about 90% of the EU limits in the past and then reduced to about 10% of the limit due to the ban on the sale of coal in 1995. These particles arise from inefficient combustion.
Particulates affect the lungs, blacken buildings and reduce visibility.

General situation in Europe

“Air quality in Europe (and particularly in the large urban areas) has improved in recent decades. However, it is estimated that in 1995 nearly all EU urban citizens were exposed to air pollution levels exceeding the (proposed) EU air quality standards set for the protection of human health.
Although implementation of the Auto-Oil measures is expected to result in significant improvements, the outlook for 2010 shows that some 70 % of the EU urban population will still be exposed to PM10 levels exceeding the limit values, some 20 % to NO₂ exceedances, and some 15 % to benzene exceedances”. –European Environmental Agency (EEA) 2010”

A new EEA study '[Impact of selected policy measures on Europe's air quality](#)' aims to provide an answer, analysing how much these policies have reduced air pollutant emissions and improved Europe's air quality compared to a 'no-policy scenario'. It also explores how much better air quality could be if the policies were fully applied.

Key findings of the EEA study

Road transport

- Despite a 26 % increase in fuel use over the period 1990–2005, the introduction of the Euro vehicle standards has reduced road transport emissions of carbon monoxide (CO) by around 80 %, non-methane volatile organic compounds (NMVOC) by 68 %, nitrogen oxides (NO_x) by 40 % and fine particulate matter (PM_{2.5}) by 60 % compared to a no-policy scenario.
- Due to lower emissions, concentrations of particulate matter over Europe have also been reduced far below the levels that would have been observed had no policies been in place. This is mainly the case for densely populated areas in western European countries. Such significant reductions have not been observed in eastern Europe.
- Due to an overall decrease in the emissions of ozone precursors (CO, NMVOC, NO_x), high daily ozone concentrations have become less frequent over most parts of Europe, especially in the Mediterranean region.

Industrial combustion

- Current emissions of NO_x and sulphur oxides (SO_x) are significantly below the no-policy scenario. The reduction in particulate matter emissions from industrial combustion is more significant than from the road transport sector. The largest reductions have occurred in major industrialised areas such as Germany, Italy's Po Valley, the Netherlands and Poland.
- Europe's air quality has improved significantly in terms of both acidifying pollutants (NO_x, SO_x) and fine particulate matter. Concentrations of both pollutants groups would be around twice as high if no measures had been implemented.

The potential of existing policies

- Emissions could be reduced much further if the latest Euro vehicle standards were fully applied in all European countries. This would mostly affect NO_x emissions from gasoline-fuelled vehicles and direct PM_{2.5} emissions from diesel-fuelled vehicles.
- In many countries, NO_x and SO₂ emissions could be approximately halved if they were brought down to the requirements set out in the LCP legislation (Large Combustion Plant).
- Concentrations of PM_{2.5}, the pollutant of major concern in terms of health effects, would decrease in most areas if countries reduced emissions to the requirements set out in the LCP legislation. As emissions in Denmark, Germany and the Netherlands are already largely consistent with the LCP requirements, high reduction potentials are mainly found in southern and eastern Europe.
- There is [scope](#) for even further improvements in Europe's air quality as many countries have not yet achieved their binding emission reductions under the [National Emission Ceilings Directive](#).

Sites, Equipment and Plans

There were 6 stations around the city measuring for suspended particulates and sulphur dioxide by the black stain and acidimetric techniques. These stations are no longer being used due to the new EU Directives that specified newer methods and instrumentation. The EU Directive 99/30/EC required member states to put in place an ambient air quality monitoring program for each state. A national air quality monitoring plan was drafted by the EPA and recommended that Cork City be served by the existing multi-element monitoring station at Old Station Road and an urban background station monitoring for PM10 (Heatherton Park).

The multi-element station, supplied and operated by Cork City Council, monitors nitrogen oxides, ozone, carbon monoxide, sulphur dioxide, lead, PM10 and benzene/toluene/xylene at Old Station Road about 400 metres south of City Hall. It is 25-30 metres from the junction with the South Link Road, Eglinton St and Albert St. The intake is about 5m from the centre of the nearest traffic lane and about 4.5 m high. It complies with the EU requirements. There are calibration gases for nitric oxide, carbon monoxide, sulphur dioxide and BTX. Calibration is now automatic at midnight every day. The instruments are serviced on contract twice a year.

There is one other station on the south side measuring for PM10 at Heatherton Park. This station is on a green area in a housing estate and should serve as an urban background monitor.

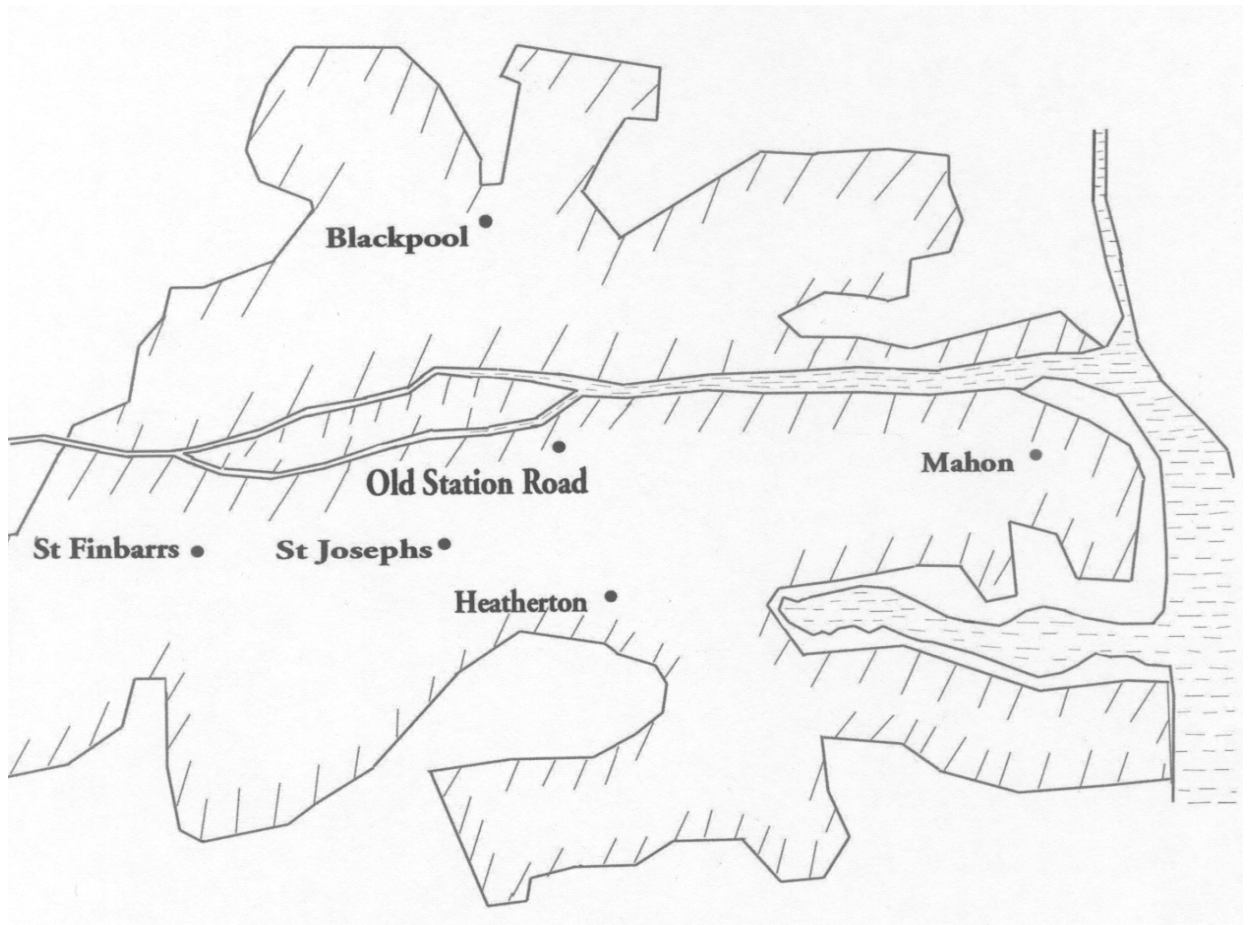
The gravimetric PM10 analyser at Old Station Road was changed to a gravimetric PM 10 and PM 2.5 joint analyser in 2001 and has now been changed in 2011 to 2 Sven Leckel instruments monitoring PM2.5 and PM10 separately. These will give increased accuracy and reliability. Problems with the instrument at Old Station Road in 2010 meant that only 167 days were sampled and a lot of summer results were not included. The average level has probably been increased because of this. A different firm has been engaged to service the instrument in 2011.

Lead monitoring ceased in 2010 because levels were so low as to be almost non detectable. Filter papers from our PM monitoring are being sent to the EPA for analysis of heavy metals and PAH to comply with S.I 58 of 2009 Regs.

The automatic monitoring equipment does malfunction on occasion. Equipment faults, once noticed, have to await repair from a service engineer located in Kilkenny. Sometimes a new part has to be ordered and this can take several weeks to arrive and be installed.

Automatic monitoring is not trouble free. Filters have to be replaced to prevent particles entering the monitoring cells and causing interference. The data collected has to be examined carefully because there are occasions when there are incorrect results due to power failures, software glitches, breakdowns, deterioration in the equipment and when the instruments are being calibrated and repaired. On the odd occasion, there are clearly incorrect results such as continuous high readings for no apparent reason until investigated by the service engineer.

From May 2004, an automatic call up and transfer of the data to the landfill laboratory site operated. The EPA can access our automatic results in real time by a telephone call up. Publishing the results, in real time, on a web site does carry the danger of supplying inaccurate and misleading information on occasion. Readings from the Cork City Council monitor are being displayed on a weekly basis on the EPA website.



Air Pollution and Health

There appears to be a number of associations between outdoor and indoor air pollution, water and soil contamination, hazardous chemicals and noise with respiratory and cardiovascular diseases, cancer, asthma, allergies, as well as disorders of reproductive and neuro-developmental systems.

There is growing concern about adverse impacts of exposures to low levels of chemicals, often in complex mixtures. Several adult diseases are suggested to be linked to exposure in very early childhood or exposure of parents before conception. Persistent chemicals with long-term effects, and those used in long-life articles, may present risks even after their production as been phased out.

A study of 250 metropolitan areas around the world found that a spike in air pollution is followed by a spike in heart attacks.

The concentration of a pollutant is not the only factor determining the impact on human beings. The duration of exposure and the health of the individuals affected are other important factors. Individual sensitivity can vary.

Some pollutants like lead can accumulate in the body. Other pollutants may have short term effects because they are transformed to less harmful substances and flushed from the body. Exposure to carcinogenic substances is best avoided at any concentration. Mixtures of pollutants can have a synergistic effect. Synergism means that the combined effects are more than additive. The standards that have been set by international bodies are part of a practical attainment strategy to progressively reduce air pollution and are not final ends or levels below which there is no effect. Standards have been revised and reduced over the years. The EU Directives in many instances specify limit attainment dates: for instance, the PM10 limit is to be reduced to one level by 2005 and to a lower level by 2010.

The concentration of any air pollutant should be kept as low as is practically possible. The American Cancer Society has declared that no level of air pollution is safe.

Particulates

They affect humans by reducing the sites available in the lungs for oxygen absorption into the blood stream. They also irritate the lungs and mucous production is stimulated. In urban areas, they may also carry carcinogens adsorbed onto the particles during the combustion process. Particulates while affecting the lungs are also strongly linked to heart disease.

Particulates have been substantially reduced due to a reduction in the use of coal. In Cork, a ban on the sale of coal is in place since 1995. Particulates may also arise from liquid or solid fuel combustion in electricity generation, space heating and transportation. Electricity generation in Cork is from gas.

A UK governmental committee (COMEAP) reports that short term air pollution episodes were responsible for 12,000 to 24,000 early deaths per year in the UK and that particulate pollution was responsible for about one third of the deaths. Short-term pollution episodes are more likely to seriously affect the weaker individuals in a community, the elderly the very young and the immune compromised. It also warns that the long term effects could be 10 times higher.

The American Cancer Society, in a study of 500,000 people in over 100 US cities

over 16 years, have found that every 10ug/m³ increase in PM_{2.5} increases lung cancer deaths by 8 % and cardiopulmonary deaths by 6 % and deaths from all causes by 4%. Smoking is the main cause of lung cancer but breathing very polluted air long term can raise the risk of lung cancer by as much as breathing second hand smoke. The study found that no level of air pollution was safe. Their work is reported in The Journal of the American Medical Association (Vol.287, No 9:1132 1141). Particles may carry adsorbed carcinogens, especially those derived from vehicle exhaust emissions. Long term exposure to even small concentrations can affect everyone and reduce life expectancy.

The UK committee (COMEAP) estimates that a 50% reduction in fine particle concentrations could improve life expectancy by 1 to 11 months on average. In comparison, a tobacco smoker is estimated to reduce his life expectancy by seven years on average.

In the UK, initial results for 2008, indicate that urban background levels averaged 20 ug/m³ and roadside stations averaged 28ug/m³. They also indicate a continued reduction in levels since records began. The UK governmental target is to reduce these to 20 ug/m³ in England and Wales, 18 ug/m³ in Scotland and 23-25 ug/m³ in London.

In Cork, average levels are 16-22 ug/m³ in the inner city roadside station and in the housing estates (Heatherton Park) they are 18-21 ug/m³.

The W.H.O report for the European Union studied air pollution levels and associated health effects in 240 cities around Europe and broadly concluded in line with the COMEAP reports (Health Impact Assessment of Air Pollution in the WHO European Region by WHO/ECEH).

U.S and European epidemiological studies (Dockery et al Ann Rev of Public Health 15:107-132; Schwarz Environ Res 64:26-35; USEPA:EPA/600/P-95/001F-cF and Katsouyanni et al BMJ 314;1658-1663) indicate an approximate 0.5 % increase in mortality for every 10 ug/m³ in PM₁₀.

The International Institute for Applied Systems Analysis in Laxenburg, Austria has proposed a methodology to estimate changes in life expectancy in Europe due to PM_{2.5} (R. Mechler et al IIASA Report IR-02-035 2002). Country average concentrations for Ireland are reported to be 7.8ug/m³ and would indicate the reduction in life expectancy is 172 days. This could reduce to 0 days if the maximum technically feasible reduction were achieved. The mean level at the Cork inner city station, in 2007 was 8ug/m³ for PM_{2.5} but 15ug/m³ for last year although this result is indicative only because of the loss of half the year mostly in summer due to instrument malfunction. It would likely be far less. The maintenance firm has been changed.

A Dublin study, through St James Hospital, on health effects due to particulate air pollution before and after the ban on smoky coals, concluded that total mortality decreased by 1.6%, respiratory mortality decreased by 13.1% and cardiovascular mortality decreased by 3.9%. The biggest effect was observed for respiratory deaths in the over 75 age group which showed a reduction of 15.7 %.

International experience and independent Irish research has shown that excessive smoke pollution is associated with increased hospital admissions, increased morbidity and a peak in mortality. Acute effects may include irritation to the eyes and throat. Chronic effects may include decreased pulmonary function and there are specific high risk groups such as the elderly, asthmatics and people with diseases of the lung.

(Potential National Ban on Bituminous Coal and Smoke-Public Consultation Paper-DOE, 2000).

Many epidemiological studies have linked particulates with cardiovascular disease and a recent Californian study has linked the formation of fatty deposits on artery walls with particulates. (Environmental Health Perspectives February 2005 Vol. 113, pp201-206. A study in Salt Lake City found that when a steel mill shut down for a period of months, there was a four to six percent drop in mortality in neighbouring areas. The mortality rose to previous levels when the steel mill reopened.

One hypothesis gaining rapid support is that many of the adverse health effects of PM are associated with oxidative stress, initiated by the formation of reactive oxygen species (ROS) at the surface of the lung. The growing literature on specific health effects in association with cellular oxidative stress, including the ability of PM to induce pro-inflammatory effects in the nose, lung and cardiovascular system is persuasive. High levels of ROS cause a change in the redox status of cells and their surrounding environment, thereby triggering a cascade of events associated with inflammation and, at higher concentrations, cell death (London Air Quality Network Report 2006-7).

Cork City Council participated with UCC, UCG, University of Birmingham and Dublin City Council on the nature and origins of particulate matter in air at sites in Dublin City (2), Cork City, Wicklow (coast) and Galway (rural). Aspects looked at included the proportion of sea salt, inorganic salts, inert dust, elemental and organic carbon in the suspended particulates at the different sites, (J. Environ. Monit., 2006, 8, 479–487). UCC examined various organics including polyaromatics and chlorinated organics in the particulates. Particulates may differ in their toxicity depending on the organics adsorbed on their surface.

Sulphur Dioxide

Sulphur dioxide is an acidic gas that arises from the combustion of fuels, particularly solid fuels, because most fuels contain sulphur as an impurity. It is irritating to the lungs and may act synergistically with particulates and other air pollutants.

Synergism means that the combined effects are more than additive. It will corrode limestone sculptures and buildings.

It may trigger asthmatic attacks but is unlikely to be the underlying cause of asthma. It may also affect plant growth.

Nitrogen Oxides

Air contains about 20% nitrogen and some of this is converted to nitrogen oxides when fuel is burnt using air as oxidant. Nitric oxide reacts with ozone to reduce ozone concentrations and in turn nitric oxide is converted to nitrogen dioxide. Being acidic gases their effects are similar to sulphur dioxide but may not be as severe. They may play a greater role in indoor air pollution.

Carbon Monoxide

It combines with the oxygen carrying sites in haemoglobin and thus reduces oxygen supply to the vital organs. In high concentrations, it can induce death although these lethal levels are never likely to be reached in urban air.

There are studies however suggesting long term effects on blood circulation for lower concentrations but more needs to be known. Smokers are subject to far higher concentrations than ambient air.

Ozone

Ozone is a reactive, oxidising gas.

It inflames the lungs of normal and asthmatic subjects. It may trigger and worsen asthmatic attacks but is unlikely to be the underlying cause. It can increase to very high levels under conditions of bright sunlight and high concentrations of volatile organics from traffic. These levels have not been approached as yet in Ireland but there seems to be evidence of some imported levels on rare occasions. Efforts to reduce nitrogen oxides in urban areas may increase the concentration of ozone. Background levels are expected to rise in the Northern Hemisphere.

Lead

Lead is a cumulative poison affecting the nervous system. It harms young children most. It was formerly added to petrol to control combustion. The ambient concentrations have spectacularly dropped under governmental tax incentives to promote unleaded petrol and now there is a total phase out of leaded petrol.

Benzene

Benzene is carcinogenic and is a component of liquid fuels. The levels in fuels are controlled by EU Directive. The WHO unit risk assessment (UR) for benzene is that 6 people will die in a population of one million when they are exposed to a lifetime exposure level of one ug/m³. The highest benzene concentrations are to be found at street level and in car parks.

Indoor Air Pollution

Indoor air pollution can sometimes be more severe than outdoor pollution.

Approximately 90% of ones time is spent indoors and this can be more for some people such as the elderly, sickly or disabled. This grouping may also be more sensitive to health effects.

The main sources of indoor pollution are carbon monoxide and nitrogen dioxide from heating and unflued cooking appliances and ETS (environmental tobacco smoke). The need to conserve heat in a building must be balanced with the provision of fresh air to reduce the risk from air pollution.

Particulates are released from cooking, smoking and general human activities.

Many building materials such as timber composites release formaldehyde.

Ionisers and photocopiers may release ozone.

Many different organic compounds are released from flooring materials, paints, sprays, etc.

Polyvinyl chloride, PVC, is an ingredient of windows and some flooring materials.

Plasticisers and lead stabilisers may be present in materials in the home.

Many small particles are released from skin, smoke, surfaces etc. House mites release droppings with allergenic effects.

Radon gas may permeate from the soil underneath.

In the sealed modern home, all these pollutants reach higher concentrations than previously.

Asthma and Endocrine Disrupting Agents

Although cause and effect relationships are hard to establish, there appears to be a number of associations between outdoor and indoor air pollution, water and soil contamination, hazardous chemicals and noise and respiratory and cardiovascular diseases, cancer, asthma, allergies, as well as disorders of reproductive and neuro-developmental systems.

There is growing concern about adverse impacts of exposures to low levels of chemicals, often in complex mixtures. Several adult diseases are suggested to be linked to exposure in very early childhood or exposure of parents before conception. Persistent chemicals with long-term effects, and those used in long-life articles, may present risks even after their production as been phased out.

The increase in asthma in children has not as yet been ascribed to a modern lifestyle impact or air pollutant. Factors under investigation are immune defects possibly due to a different pattern of exposure to worms or bacteria in childhood. It is said that children today are raised in a more sterile environment. There is more exposure to people from a young age to household chemicals and air pollution. Currently, polyaromatic hydrocarbons (PAH'S) present in exhaust fumes are under investigation as possible causative agents. In an asthmatic condition, the lining of the bronchial tree becomes inflamed and allergens, pollution, viruses or physical stimuli such as exercise or inhaling cold air can trigger attacks.

The general consensus at the moment is that air pollutants are more likely to trigger asthmatic attacks rather than be the cause of the problem.

Research on endocrine disrupting chemicals that may cause reduced sperm counts and breast cancers is ongoing. A wide range of sources is possible including foodstuffs, pharmaceutical drugs, drinking water and air pollution.

Legislation

The Air Pollution Act

The Act of 1987 enabled local authorities to licence a range of industrial processes, prevent air pollution from premises other than domestic dwellings, prescribe notices containing measures to prevent pollution from any premises, make air quality management plans and special control areas. The owner or the occupier of a premises is obliged to use the best practicable means to prevent pollution.

The licensing function was generally transferred to the EPA in the 1992 Act although some activities can still be controlled by licence. Most of the other functions remain.

The Environmental Protection Acts 1992 and 2003

The 1992 Act set up the EPA and described its functions. Its main activity has been to licence those activities that pose most risk to the environment. Impacts on air, water soil and other environmental matters such as waste arisings, noise etc are considered in the integrated pollution licence (IPC licence now called IPPC licence). The EPA also monitors the environment generally, oversees the functions of the local authorities as they relate to the environment, liaises with the European Environment Agency and carries out research.

The Act also contains a section for the control of noise by the EPA or by the local authorities.

EU Directives and Irish Regulations

Up to 1996, separate Directives were issued for the control of air pollution

parameters such as Directive 80/779/EEC of 1980 on air quality limits values and guide values for sulphur dioxide and suspended particulates.

The 1996 Framework Directive on air quality established a structure for the long term control of air pollution.

Subsequent "daughter" Directives set ambient air quality standards for 12 pollutants. The first two of those have been adopted. These control particulates, nitrogen oxides, sulphur dioxide, lead, benzene and carbon monoxide. These have transcribed into Irish Regulations (S.I No 271 of 2002). The third Directive, controlling ozone, has been published (2002/3/EC). The limit for ozone will be 120 ug/m³ as an 8 hour average not to be exceeded more than 25 times a year by 2010 and no exceedance by 2020. The information threshold is 180 ug/m³ and the alert is 240 ug/m³. The transboundary effects and control have to be agreed between states.

A fourth daughter Directive has set limits for heavy metals and benzo(a)pyrene. This Directive has been transposed into Irish legislation by S.I 58 of 2009.

A new proposal will limit the amount of volatile organics in paints, varnishes and vehicle finishing materials in stages up to 2010. These compounds contribute to photochemical smog.

Irish Regulations put these Directives into force in Ireland. Regulations can set lower limits than in the Directive. The Minister is empowered under several Acts to make Regulations from time to time. An example is banning the sale of bituminous coal through the powers given in the Air Pollution Act, the S.I No. 118 of 1998 (Marketing, Sale and Distribution of Fuels) Regulations 1998, these Regs replaced previous Regs specific to Dublin and Cork.

Air Pollution Reduction

The most effective way to reduce pollution in general is to eliminate or reduce the source rather than treat the emissions.

The main sources of air pollution in the urban situation are the combustion of fuel for transportation and space heating.

The main instrument for change is at EU level, regulating the emissions from vehicles produced by the motor industry, other sectors of industry and setting ambient levels.

The EEA calculates that there has been very significant reductions in traffic emissions due to catalytic converters, reduced sulphur in fuel and particulate traps but the increased fuel consumption has tended to negate these improvements. Monitoring has shown that there has not been a corresponding decrease in ambient levels perhaps due to the increased use of diesel powered vehicles and the more NO_x being released as NO₂ (EEA Report No1/2008).

There are developments in renewable energy, fuel cell and hydrogen fuel systems not alone to provide better air quality and the prevention of global warming but also in the interests of costs and energy security: fossil fuels are a dwindling resource.

Nuclear energy provides clean electrical power but the nuclear industry in its current form has problems with emissions and waste disposal. Energy from sun, wind and wave may be converted to electricity or to cleaner fuels like hydrogen. Heat exchange with groundwater or thermal springs may heat homes. The old alternatives of walking and cycling should be promoted to a greater extent.

The cleanest fuel that is currently available is natural gas. Particles and many other pollution parameters are much reduced compared to other fuels but gas still emits nitrogen oxides and greenhouse gases when burnt. Hydrogen powered vehicles and those operating on fuel cells are cleaner than natural gas but they are not yet commercially available. Electrically powered vehicles do not have emissions but the power stations generating the electricity do. The proportion of electricity produced from cleaner, renewable sources is increasing. Fuels such as vegetable oils will release pollutants locally but they are of benefit in that they are renewable and do not increase the overall levels of carbon dioxide in the atmosphere.

At a national level, the phasing out of leaded petrol has reduced lead in urban air by about 99%. Similarly, the ban on the sale of bituminous coals has reduced particulate levels significantly and by about 70 % in Cork. Taxation policies can exert a significant influence on pollution levels. Bus and taxi fleets could be encouraged to move from diesel to cleaner fuels such as gas/electric hybrids. The EPA issues IPPC licences that regulate the emissions from large combustion plants and industrial emitters.

At a local level, various reduction strategies have been tried to curb the use of fossil fuel powered cars. There has been banning of single person motoring, incentives for carpools, park and ride, banning odd or even numbered vehicles on alternate days (Paris), area bans combined with increased and better public transport, user charging, parking charges, different school times and road tolls (UK).

Pedestrianisation, cycle lanes and living closer to work, schools and shops can help reduce traffic air pollution. Possibly, Internet shopping might also reduce the number and length of journeys. Convenient communities where people live in locations where work, home, schools and shops are closer together are less dependent on cars and combined with clean efficient public transport, pedestrian and cycle friendly areas, these locations are cleaner and healthier. These convenient locations could be

encouraged in development plans or by taxation incentives rather than widely separated into residential, industrial and commercial zones. The old model of a factory/workplace surrounded by the homes of people who work there could be again be considered. Tax incentives could encourage home ownership closer to work and/or workplaces being brought nearer to homes. Environmentally friendly policies and convenient locations would reduce costs for new road infrastructure, personal and commercial transportation and healthcare. It would help to reduce global warming, dependence on imported fuels and reduce accidents. It would help to prevent the unsightliness of major roadways crossing our green landscape.

Some regions have declared an intention to ban the future use of fossil powered cars, (Lombardy/Milan) and California has ordered that an increasing proportion of fuel celled vehicles be sold. Many cities/ regions have experienced high pollution episodes and this has led to these strategies having a measure of public acceptance for a time. It is more difficult to convince people of the long-term health effects of small pollution doses. In the UK, the Governments chief scientific advisor has advocated that deadlines are needed to end the sale of petrol and diesel vehicles because of the effects on air quality and climate change.

Even where air quality meets international standards now, cognisance should be taken of the fact that there is no level of air pollution that is safe. Policies for recovery could include limitations on traffic flow, closure of traffic routes, congestion or toll charges and restrictions on fuel types.

Road developments such as urban bypasses that reduce the build up of slow moving traffic may help to reduce traffic pollution in the short term but, long term, they encourage new developments and then extra traffic.

Space heating is also a major contributor to air pollution. Better building design, insulation and greener heating strategies are required.

Modelling

Emission inventories provide figures for the different sources in an urban area. The main sources are space heating, traffic and power generation. These sources vary through the day, through the seasons, and from area to area. The different pollution parameters can also vary depending on source. The urban area can be divided into grids of emission quantities and thereby allow mathematical modelling.

The eventual concentration in any location will also be dependent on wind and weather.

Modelling provides information on where the highest average concentrations and maxima may be expected and also can give a pollution contour map.

Generally the highest average concentrations are located in the north east centre of our urban areas due to the prevailing wind direction however inversions may induce high concentrations for shorter periods and these may be in a different location depending on wind drift.

The information from modelling and emission inventories can help to decide on the best and most cost effective strategies to reduce air pollution particularly at a local level.

European Union

The EU is progressively reducing the limits on emissions for new cars and the motor industry responds through the use of catalytic converters and improved engine technology. There is a limit on the reduction of motor vehicle pollution through these means and new developments such as fuel cells, electric power or hydrogen fuel

may be necessary, especially with the continuing rise in car numbers.

European Union air quality policy up to now has consisted of four strands:

1. The adoption of a series of directives setting binding limit and target values for ambient air quality.
2. The setting of national emission ceilings for certain pollutants in a directive. Each country must achieve emission limits for the four parameters SO₂, NO_x, VOCs and NH₃ by 2010. These pollutant affect acidification, ground level ozone formation. This Directive is distinct from the Kyoto Protocol affecting greenhouse gases.
3. A series of ever-stricter vehicle emission and fuel quality standards in connection with the Auto Oil programs emissions
4. Standards for other sectors including limit values for large combustion plants, incinerators and solvent-using industries, and the general requirement to use best available techniques for the operation of the large industrial installations.

A new clean air for Europe program has been launched by the EU commission that sets in train a continuing review and new reduction policies.

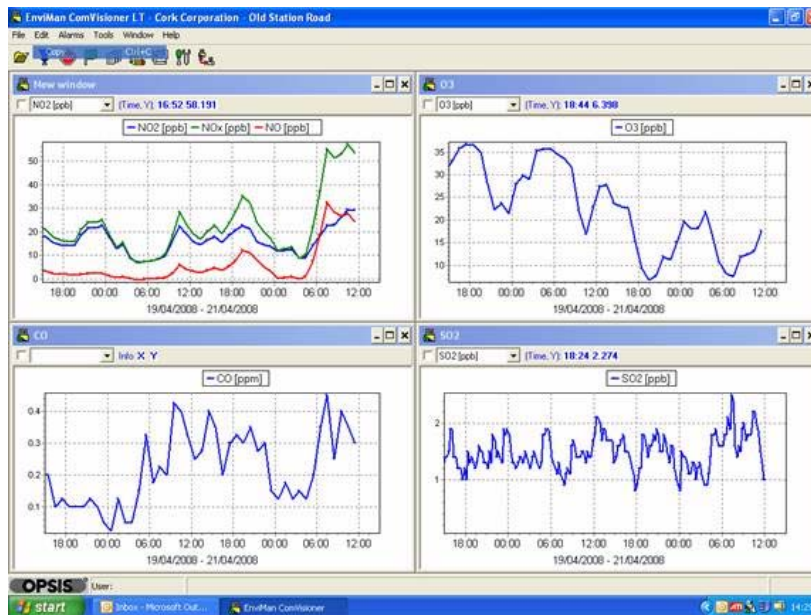
Factors affecting Diurnal Pollution Variations

Pollution concentrations vary greatly during the day and from day to day. These concentration differences are due to different emission patterns, weather variations and urban morphology.

Traffic emissions are highest in the morning rush hours and to a lesser extent in the noon and evening rush hours. Space heating systems also begin in the early mornings during the winter season particularly in the city centre where the monitoring station is located. Although in the city as a whole, space-heating emissions should be greatest at night-time.

Weather variations play a very important part in urban pollution concentrations. Winds tend to increase during the day so the morning rush hour when emissions are highest is often accompanied by less windy conditions and hence less dilution. In the evening rush hour, the wind may not yet have reduced from daytime levels and hence there is more dilution available. Pollution concentrations are generally highest in the mornings although this trend may not apply to the same extent in winter. In winter weather inversions may occur. A weather inversion is where unusually colder air occurs near the ground and is overlain by warmer air. It produces very poor dilution. It occurs during winter nights when there is an anticyclone that is accompanied by windless conditions and a cloudless sky. Warmer, windy and wet weather will produce better dilution for emissions.

Urban morphology is important because narrow streets with high buildings should contain pollutants to a greater extent than wide streets with low buildings.



19 april cold strong north easterly wind. Felt very cold. Overcast temps about 9C
20 april milder slacker north easterly. Overcast. Temps 10C
21 april milder lighter northeasterly Overcast Temps 12C

Trends in Traffic Pollutants in Recent Years

The opening of the Lee Tunnel in May 1999 diverted some traffic for a while from the Old Station Road area where the monitor is located.

Traffic counts in roads from and on to the South Link Road declined a little between the years 1996 and 2000 but have increased by 17% from 2000 to 2007 (Noel Tummon, Traffic Dept Cork City Council).

Many other European countries have experienced a drop in traffic pollution parameters over the last ten years. In Ireland there has been a major increase in car numbers overall although more of the fleet now use catalytic converters and improved engine technology as in Europe. Air pollution has been decreasing slightly in Ireland too.

There has been a major decrease in smoke concentrations since the ban on the sale of coal and likewise a dramatic fall in lead since the phase out of leaded petrol.

Particulates as measured by the PM10 parameter have been decreasing slightly although this trend seemed reversed in 2010.

Nitrogen dioxide concentrations are decreasing slightly.

Carbon monoxide concentrations are decreasing slightly.

Average ozone concentrations appear to be stable.

Sulphur dioxide levels appear to be stable.

Average benzene appear to be stable.

Air Monitoring Results

Explanation of Terms Used

Samples taken for lead are weekly averages, samples for particulates and sulphur dioxide (acidimetric method) and PM10 are daily averages, samples for nitrogen oxides, ozone, sulphur dioxide (fluorescent automatic) and carbon monoxide are hourly averages, samples for B.T.X (benzene, toluene, xylene) are 15 minute averages.

An enormous amount of data is generated, in a year, that to make sense has to be processed into statistical terms. Maxima and means (averages) are familiar terms. The 98 percentile is the 98th highest value per hundred or 0.98N where N is the number of values in ascending order. It is similar to the highest value but has less risk of being an erroneous outlier. The median is the middle value in a set. Moving or rolling averages are values taken for overlapping time periods such as 1-8, 2-9, 3-10 a.m. etc. It is the maximum moving average that is considered. The WHO use a term called unit risk (UR). It is the excess risk of dying from cancer following a lifetime exposure. For benzene, 6 persons will die in a population of one million when exposed to a concentration of 1ug/m³ for a lifetime. This is expressed as 6x10⁻⁶ (ug/m³).

Generally, standards include more than one statistical parameter because one statistic may not give a true representation of the effect on the environment and humans. Averages may not consider short term stresses. There is an old saying that a man can drown crossing a river that is on average 6 inches deep. On the other hand, a very short pollution episode may not have a significant effect but one of several hours or days may have. Averages may be combined with 98th percentiles or maximum moving averages. The properties and health effects of the parameter are important in choosing the standard. Computer software calculates these statistics. The year for most parameters is the calendar year.

The year for suspended particulates (smoke) and sulphur dioxide was from 1 April to 31 March because these parameters were mostly relevant to winter space heating and the time period is specified in an EU Directive. These parameters are no longer operative in that form.

The times shown are winter times (GMT).

Parameters

1. Suspended Particulates
2. PM10 and PM2.5
3. Sulphur Dioxide
4. Nitrogen Dioxide
5. Nitric Oxide
6. Ozone
7. Carbon Monoxide
8. Lead
9. Benzene

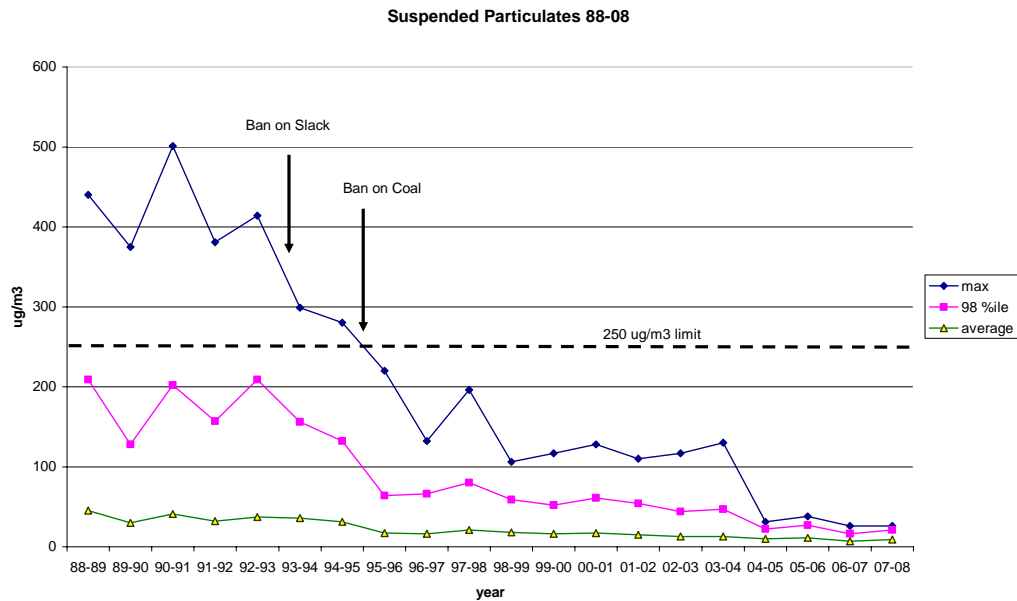
1. Suspended Particulates

The suspended particulate parameter was introduced to monitor for the effect of bituminous coal in urban areas. It has now been replaced with the PM10 parameter. Particulates arise from the inefficient combustion of fuel. Visually the emissions can be seen as smoke coming from chimneys burning coal, oil burners and traffic. Most particulates are generated at the beginning of combustion or during refuelling when the burners are relatively cold. Small particles or tarry materials are not burnt completely in the still relatively cool grate but are drafted out of the burning chamber. They are irritants to the respiratory system, affect heart function and may carry adsorbed carcinogens. The great smog of London in December 1952 is believed to have caused 4000 premature deaths.

Discussion

Monitoring for this parameter ceased in 2008. The variation in suspended particulates over the years is presented in Fig 1. It shows the decline in levels for the network of six stations since the ban on the sale of slack in 1993 and particularly the ban on the sale of coal in 1995.

Maxima and 98 %ile concentrations will fluctuate from year to year depending on the occurrence of inversions and the general coldness of the winter. An inversion is where a warm air layer overlies a colder ground air layer and is opposite to the normal situation. It occurs when the layer nearer the ground loses heat rapidly such as on anticyclonic and cloudless nights through radiation to space.



2. Particulate Matter PM

This parameter is a replacement for the suspended particulate parameter. Epidemiology has shown a clearer connection between this parameter and health effects. It mostly measures particles less than 10 micron in size in contrast with the suspended particulate parameter that measures all sizes of particles. The method differs also in directly weighing the filter whereas the older method measured the blackness of the stain on the filter. The sampling year for PM10 is the same as the calendar year in contrast to the suspended particulates parameter which is from 1 April to 31 March.

Particles of this size (less than 10 um) penetrate more deeply into the lungs. Another parameter, PM 2.5, shows an even better relationship with health defects. This is also being measured in Cork. Vehicle particulate emissions have potential to cause adverse health effects like pulmonary and cardiovascular diseases but also cancer because of adsorbed carcinogens. A Partisol PM10 and PM2.5 analyser (gravimetric) is in operation at Old Station Road. A Partisol PM10 analyser (gravimetric) is in operation at Heatherton Park.

Table 1, 2010 results(ug/m3) (previous years in brackets)

	Old Station Road		Heatherton Park
	PM10	PM2.5	PM10
Average	22 (18) (16)	15 (8) (9) (8)	18 (15) (15) (17)
Number > 50ug/m3	7 (6) (1) (1)		8 (10) (1) (1)

Problems with the instrument at Old Station Road in 2010 meant that only 167 days were sampled and a lot of summer results were not included. The average level seems to have increased for PM10 and 2.5 because of this but this may not be the case. A different firm has been engaged to service the instrument in 2011.

Comparison with Standards

The Irish Regulations (No. 271 Of 2002) require that 50 ug/m3 be not exceeded on more than 7 days starting in 2010.

Unfortunately, there were problems with the instrument at Old Station Road in 2010 and there was a long period in the summer when the maintenance firm employed could not repair the instrument. The instrument for 2011 has been replaced with a Sven Leckel type and a different maintenance firm has been engaged to service the instrument. The Leckel pumps more air, should be more accurate, and is the one now recommended by the EU.

At Old Station Road, 7 samples exceeded 50 ug/m3 so the standard was just met with reference to this criterion. Last year there were 6 exceedances. The exceedances were in the severe cold snaps of January and December. The last two years were remarkable for extremely cold winter spells.

At Heatherton Park the number of exceedances of the 50ug/m3 limit was 8. These

exceedances reflect the extremely cold winter spells in the last two years that caused an increase in solid fuel burning. Heatherton Park exceeded the EU standard. The annual mean limit in the Directive from January 2010 is 20 ug/m³. The monitored value is 22 ug/m³ at Old Station Road and 18 ug/m³ at Heatherton Park. The standard was exceeded at Old Station Road but because the instrument was not operating during the summer times when far lower levels would be common there is some doubt as to whether the standard was exceeded.

There is no standard for PM_{2.5} as yet but the USEPA have 15 ug/m³ as an annual mean limit. The average concentration at Old Station Road last year was 15ug/m³ although there is some doubt about this figure. The EU may set average levels at 25ug/m³ for implementation by 2015.

Discussion

PM concentrations were reducing at both stations until the extremely cold winters of the last two years that caused an increase in domestic solid fuel heating. The average level at Old Station Road has fallen from 26 to 22ug/m³ and the number of samples exceeding fifty has fallen from 28 to 7 since monitoring began in 2000. In the UK, results for 2009 indicated that urban background levels averaged 19 (20 in 2008) ug/m³ and roadside stations averaged 22 (28 in 2008) ug/m³. They also indicate a reduction in levels since records began.

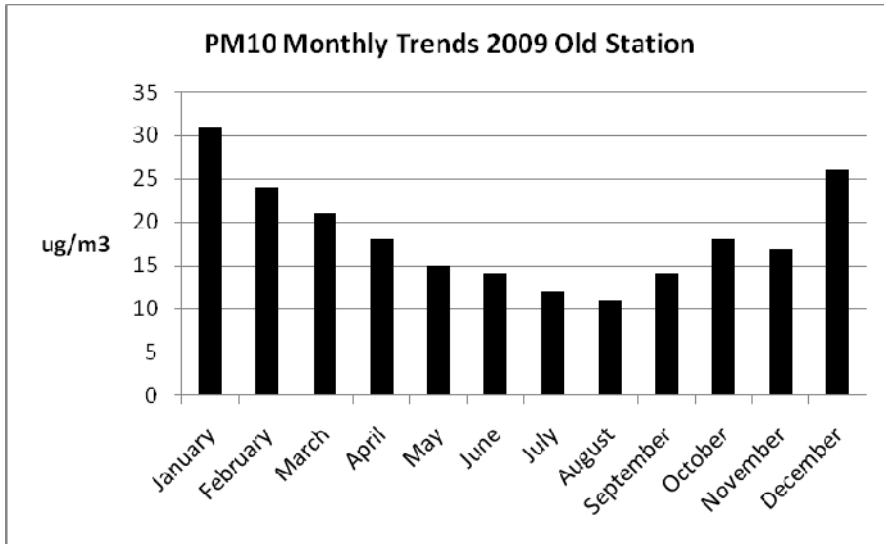
PM₁₀ is a form of suspended particulates but there are two important differences between it and the older Black Smoke particulate method. The PM₁₀ method determines smaller size particles i.e. those less than 10 microns in size mainly whereas the older method determines these and bigger particles.

The second difference is that for the PM₁₀ gravimetric method, particles are weighed directly (or by a method shown to be equivalent). In the 1950-1990s balances accurate to weigh to 0.01 mg and lower were not in widespread use so measurements were made by a reflectometer. Incompletely burnt coal particles create a black stain on a filter paper. The blackness of the stain was determined by a reflectometer (measures the amount of white light reflected from the blackened paper). A chart or formula was distributed to all the laboratories using the method in order to convert the blackness of the stain to particle weight. It was always understood that the method was approximate only and allowances were made in standards and interpretation. Particles derived from diesel are blacker than coal and there were also differences in blackness between different types of coal.

The limit for suspended particulates has now been effectively reduced from 250 ug/m³ to 50 ug/m³ reflecting the increased concern about the health effects of this parameter.

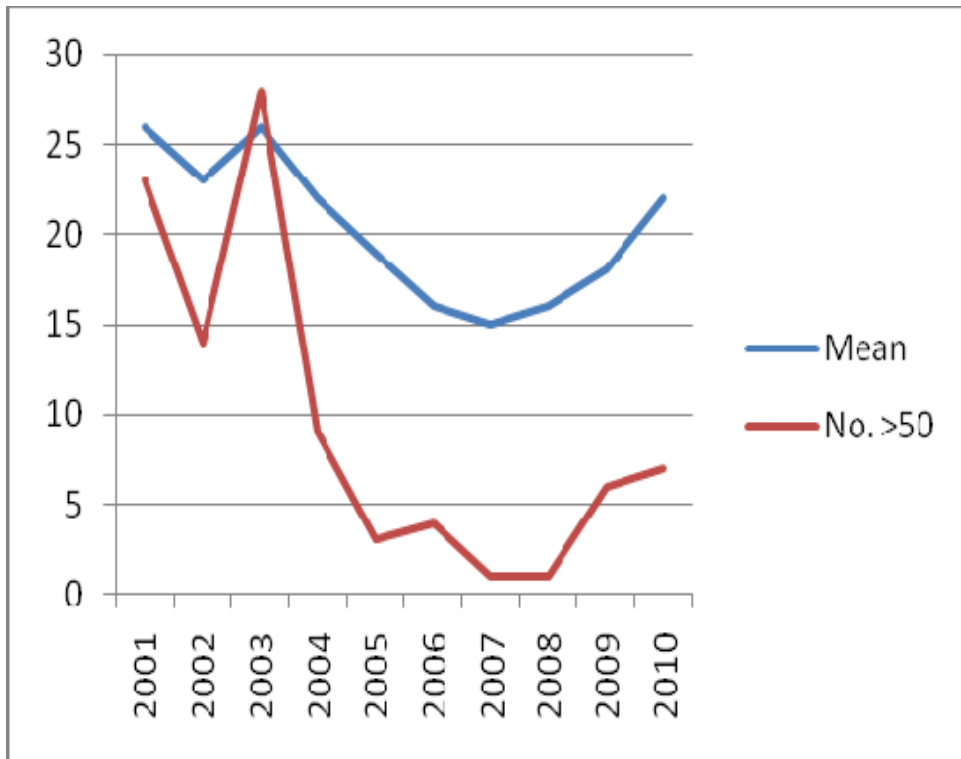
The chart below shows that concentrations are higher in winter.

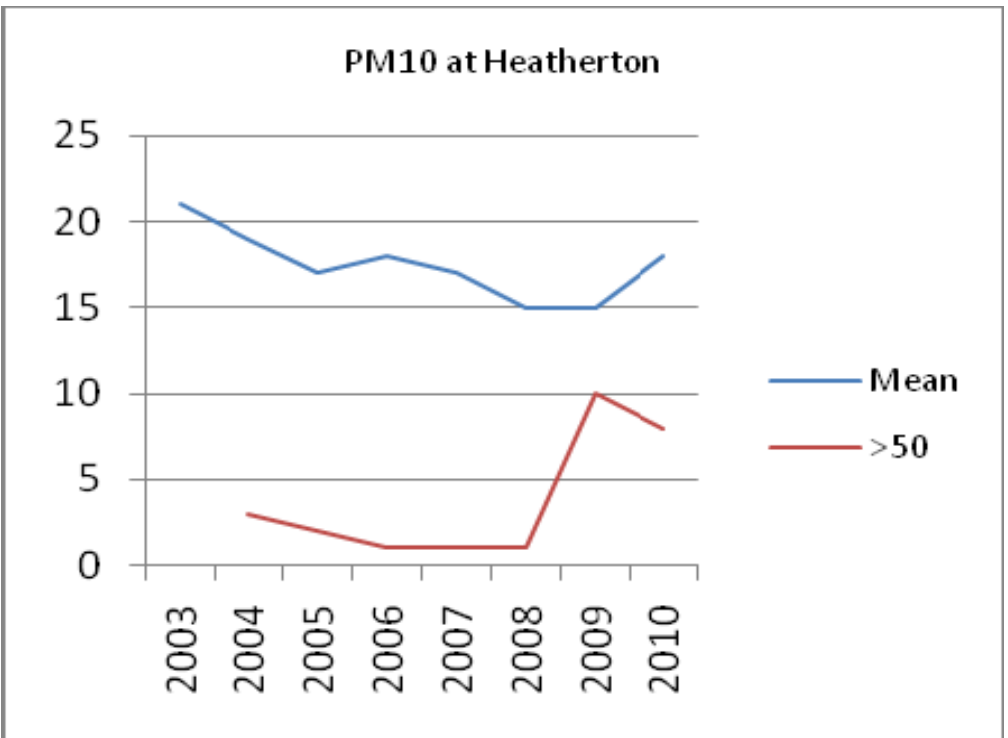
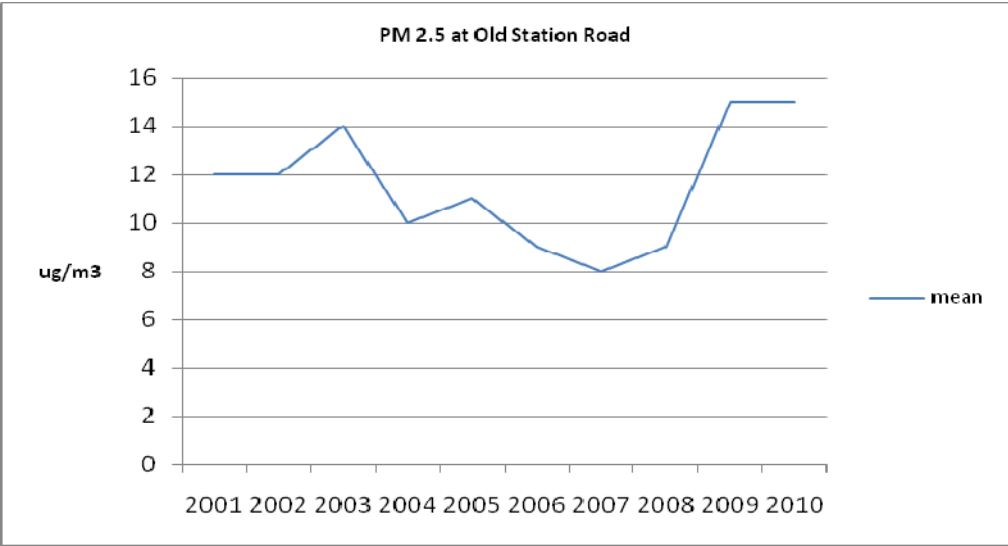
This reflects the contribution of space heating and the different dispersion characteristics due to weather.



The following chart depicts the trends in the last ten years at Old Station Road (Environment Lab). Old Station Road is the small link road between Anglesea St and the South Link.

Many other European countries have experienced a drop in pollution parameters over the last ten years. Obviously the severe cold spells of the last two years have had a major effect on the trends.





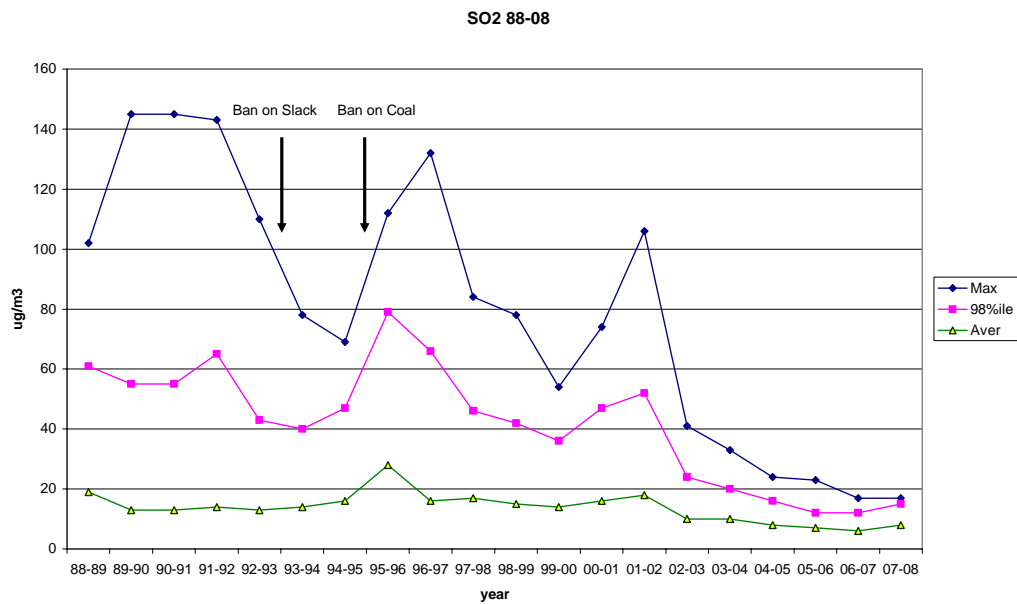
3. Sulphur Dioxide

Old Acidimetric technique

The old acidimetric technique to determine SO₂ has been replaced by the automatic fluorescence technique. Most fuels contain small amounts of sulphur as an impurity and when burned sulphur dioxide is produced. It is acidic and irritating when breathed.

This method can best be described as approximate only at the low levels being encountered in Cork. It is no longer being monitored by this technique.

The chart for the old acidimetric technique over the last 20 years showed a decreasing trend due to the phasing out of coal.



Fluorescent Method for SO₂ and Standard

A new standard from the EU, transposed into Irish Regs (271 of 2002) has a requirement for hourly samples by the fluorescent method. This new automatic method based on fluorescence is in operation at Old Station Road since 23/04/99. The old acidimetric method measured 24 hour samples only.

Results for 2010 (previous years in brackets)

1. The maximum value recorded for the one hour sample was 58 (44) (41) ug/m³.
2. The max 24 hour value was 39 (27) (21) (18) ug/m³
3. The average one hour value was 16 (9) (4) (6) ug/m³.

Comparison with Standards

The new EU standards require:-

1. 350ug/m³ not to be exceeded more than 24 times a calendar year for the hourly readings. The max recorded was 58 ug/m³ so this is in compliance.
2. 125ug/m³ not to be exceeded more than 3 times a calendar year for the daily readings. The max recorded was 39 ug/m³ so this is in compliance.

Discussion

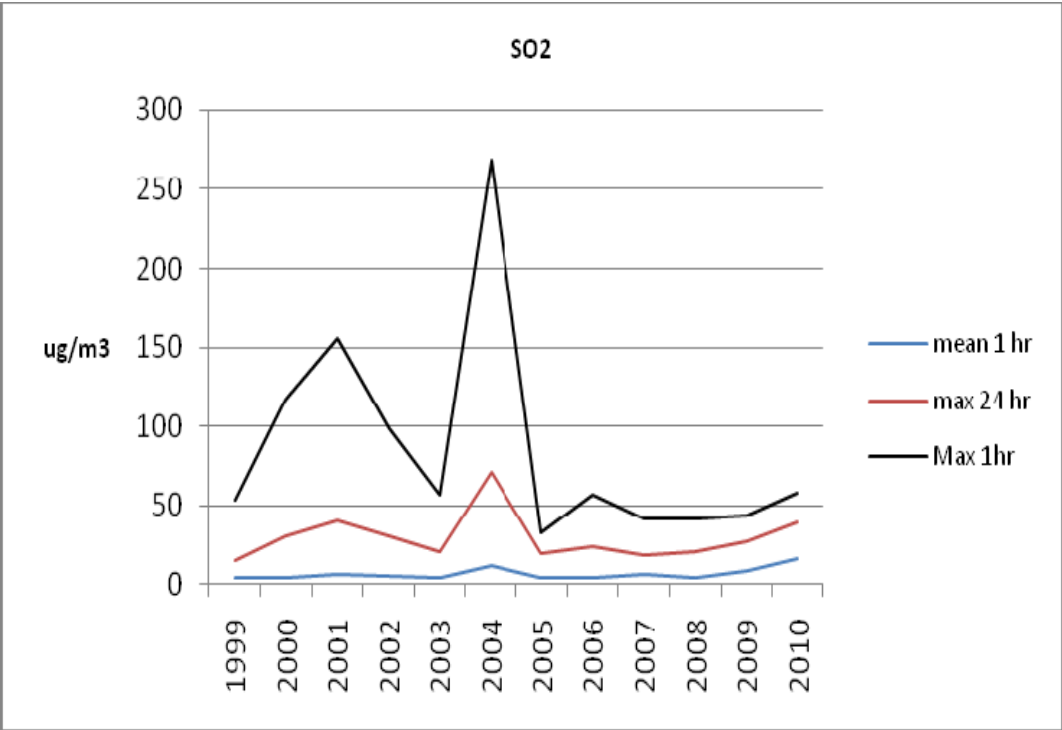
The results are well within the limits required by the EU directive. The monitor does not function very accurately at the low concentrations found in Cork. There is some drift and inconsistency.

Difference between the Methods

It was always realised that the old acidimetric method at low levels was inaccurate: a titration figure of 0.1 ml was about equivalent to 7ug/m³ and there were other factors that tended to make the results approximate only. The length of the intake PVC tubing and its age tended to increase the potential of acid leachate from the tube itself causing a positive interference. A negative interference could be caused by ammonia sources such as toilets, animals etc. Errors were also likely due to drift in the pH of the solution at 4.5 before and after the sample exposure.

Nevertheless the old acidimetric method begun in the 1950's and intended to provide a widespread coverage of SO₂ levels was useful in its time. The results are more accurate above 100 ug/m³ at which point the guide and maximum levels in the legislation become more significant.

The newer method is also subject to error at the low levels being experienced.



4. Nitrogen Dioxide

Nitrogen oxides arise in air from the high temperature oxidation of fuels. Nitrogen in the air supply to the engine is oxidised by reaction with oxygen at high temperatures to form nitrogen oxides.

Nitric oxide is the main gas emitted and this reacts with ozone and more slowly with oxygen to form nitrogen dioxide. Ozone levels in the locality fall as a result.

Eventually nitrogen dioxide is removed from the air by rain.

It is an irritant when breathed.

Results for Nitrogen Dioxide

The results for the year 2010 are displayed in Table 1 (ug/m³, 1 hour) (preceding years in brackets).

Table 1 (ug/m³)

Range	Average	98%ile
1.7-168 (0.4-166) (0.2-134)	34 (34) (26) (28)	92 (91) (69) (74)

Comparison with Standards

The new EU limit is 200ug/m³ for hourly values, not to be exceeded more than 18 times a calendar year. The highest hourly value was 168 ug/m³.

The average of 34 ug/m³ is below the 40ug/m³ average for the protection of human health but is beginning to approach it.

The average of 34ug/m³ is above the 30 ug/m³ average for the protection of vegetation.

Comparison to Previous years

The 98%ile has generally decreased over the years but in the last two years it has increased. This may be due to the severe winters promoting increased space heating.

Weather conditions such as inversions could be a contributory factor.

The concentrations of NO₂ are influenced by winter space heating as well as traffic.

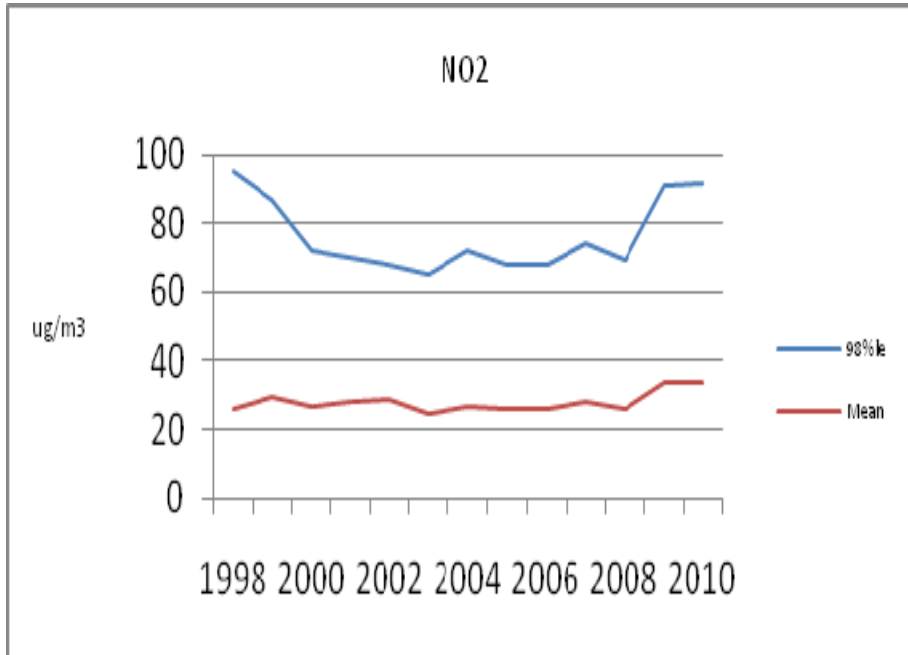
The Lee Tunnel opened in May 1999 and there seems to have been a drop in the higher values (98%ile) the following year.

Concentrations should be declining due to the Lee tunnel and because of the increased use of catalytic converters. On the other hand, the increase in car numbers on the roads generally should be increasing concentrations.

The eventual outcome is probably a compromise on these different factors.

The following chart depicts the trends in the last thirteen years at Old Station Road (Environment Lab). Old Station Road is the small link road between Anglesea St and the South Link.

It would appear that the severe winters of the last two years may be responsible for the increase in NO₂ levels.



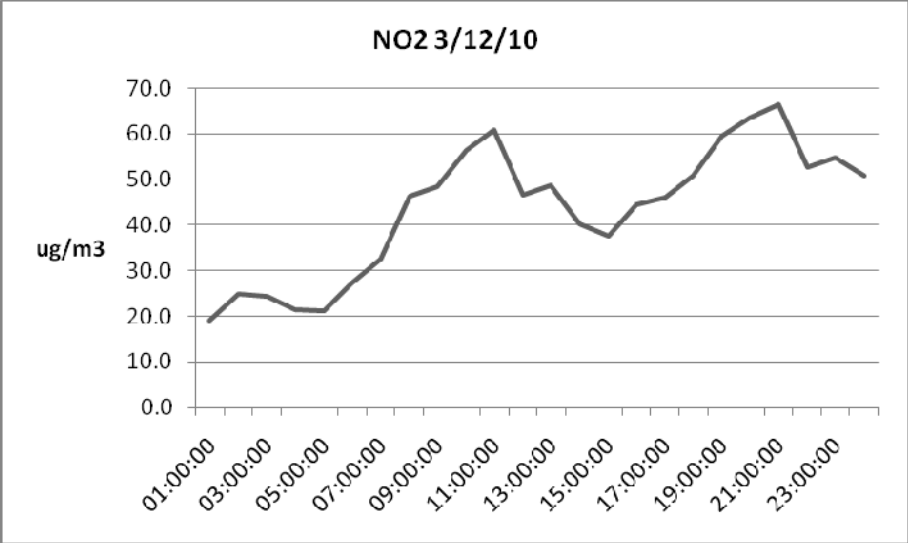
Discussion

Space heating is an important emitter. As regards traffic, catalytic converters, cleaner fuels, better engine technology and maintenance, alternative transport and a reduction in traffic congestion are factors that tend to reduce the concentrations in air while an increase in traffic volumes will increase concentrations. Power generation is another source.

Concentrations are lowest in mid summer.

There are significant diurnal variations. Peaks are generally observed in the morning and evening rush hours. This is the overall pattern but it would be very rare for two days to be exactly the same. These variations are due to colder temperatures (increased space heating), wind direction and strength, traffic numbers etc. The weekdays tend to have a different pattern to weekend days. At weekends, the morning peaks are not as apparent, there is a slow more gradual rise and in the evenings, there may be a rise due to travelling for social purposes.

The chart below for Tuesday 3/12/10 shows a rise about the morning rush hours and a continuation to midday, there is a slow decrease until the evening rush hour and then an increase during the evening to 2100 and a slow decrease. This was a very cold cloudy day with minimum temps of -4C and a max of +4C.



6. Ozone

Ozone arises naturally from ground level production due to sunlight and downward diffusion from the stratosphere. In the stratosphere, ozone protects us from harmful UV radiation but at ground level, it is harmful to human and plant life. There has been an increase over the last fifty years in world ambient ground levels due to pollution from volatile organic compounds. The normal ambient ground concentrations are 40-110ug/m³.

The generation of nitric oxide from traffic and domestic heating normally reduces ozone levels in urban areas because it reacts with ozone to form nitrogen dioxide. In conditions of high traffic density, producing large amounts of volatile organics combined with high sunshine levels, a different series of reactions dominate and can lead to elevated ozone levels of 1000ug/m³. Such conditions can exist in USA and Continental Europe but are not seen as yet in Ireland. Some importation of this effect is possible depending on weather conditions.

Standards

The WHO guide is 120 ug/m³ for an 8 hour average.

The third EU daughter Directive, controlling ozone was agreed in November 2001. The limit for ozone will be 120 ug/m³ as an 8 hour average not to be exceeded more than 25 times a year by 2010 and no exceedance by 2020. The information threshold is 180 and the alert is 240ug/m³. The trans boundary effects and control have to be agreed between states.

Results

The results are presented in Table1 for the year 2010 (ug/m³, 1 hour). Previous years' results are in brackets.

Table 1

Range	Average	98%ile
-0.04-131(0-234 (0-125)	32 (36) (39) (33)	69 (74) (86) (72)

Max 8 hr. Running Average = 113 (114) (112) (96) ug/m³

Comparison to Standards

The 8 hour running average threshold of 120 ug/m³ was not exceeded, the standard is for a maximum of 25 exceedances by the year 2010.

The one hour information level was not exceeded.

Individual states can often do nothing about the levels – they may be as a result of pollution imported from other states and/or natural sunshine events.

Terpenoids from plants can also contribute in rural areas. Rural stations in Ireland experience higher levels of ozone than urban areas. Levels decrease in urban areas because nitric oxide in the air is converted to nitrogen dioxide using the available ozone.

Variations

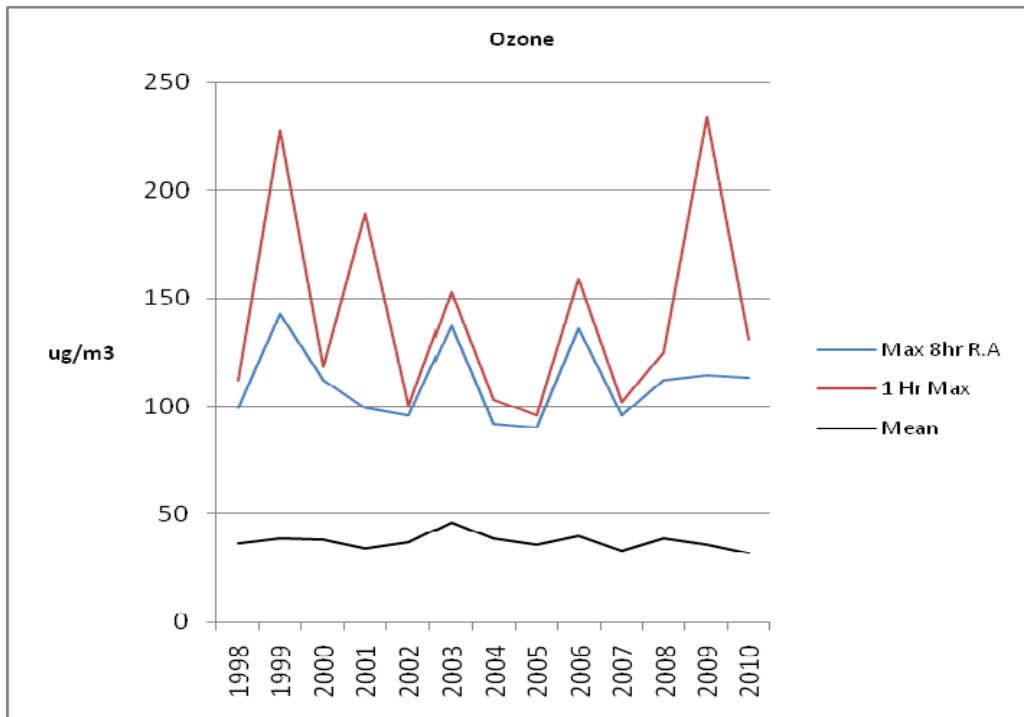
Concentrations are usually higher in summer than in winter due to less NO being available and also sunlight producing ozone.

Usually there is a diurnal variation with concentrations being reduced during the morning rush when nitric oxide is produced. There is an increase during the night when less NO is available.

The following chart depicts the trends in the last thirteen years at Old Station Road.

Old Station Road is the small link road between Anglesea St and the South Link.

Average levels are stable over the years but short-term peaks seem to occur in warm summers.



7. Carbon Monoxide

This invisible odourless and toxic gas is produced by the inefficient combustion of fuel. In contrast to the other parameters in the Report, carbon monoxide is measured in mg/m³ (milligrams per cubic metre) rather than ug/m³ (micrograms per cubic metre). It is present in far greater quantities than the other parameters, often one thousand times more.

Standards

The W.H.O guidelines are 100 mg/m³ (15 minutes), 30 mg/m³ (1 hour) and 10 mg/m³ (8 hour). Irish Regulations transposing the EU Directive require from Jan 1 2005 a limit of 10 mg/m³ for an 8 hour running mean.

Results

The results for 2010 are presented in Table 1. Previous years are in brackets.

Table 1 (One hour, mg/m³)

Average	Max	Min	Max 8 hr Run. Average
0.4 (0.4) (0.5)	5.5 (14.5) (3.8)	-0.01(0) (0) (0)	4 (3.5) (2.2) (2.8)

Comparison with Standards

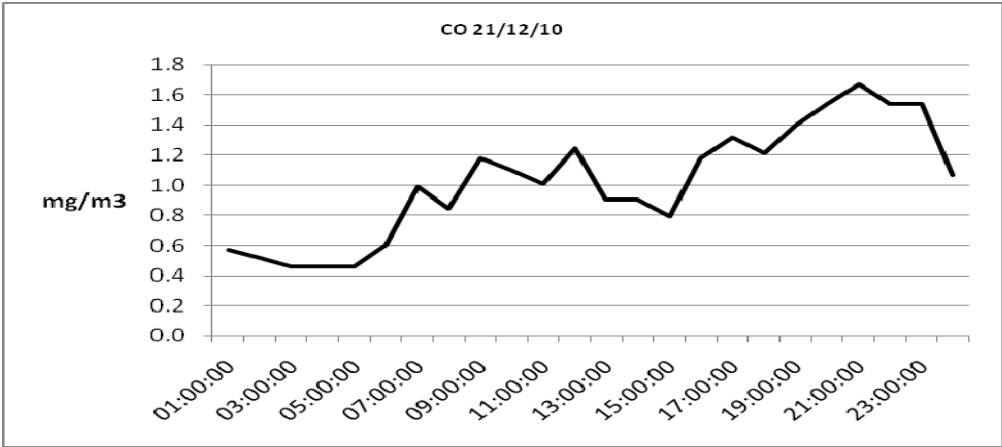
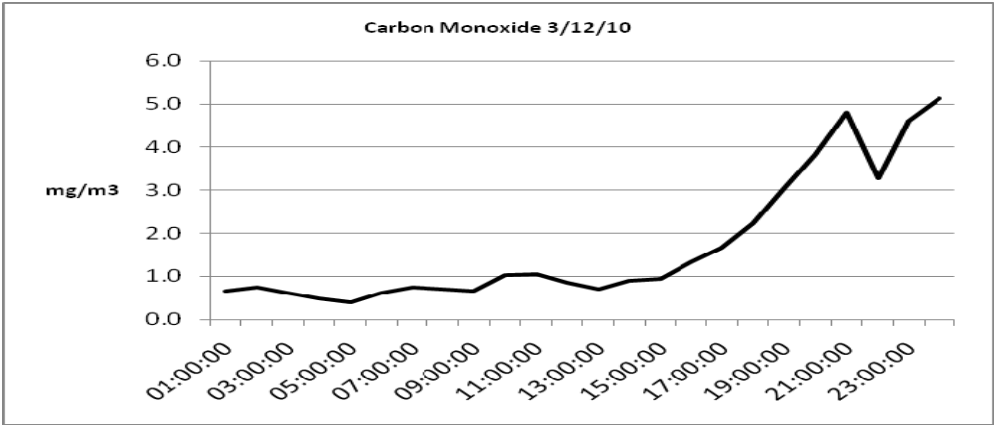
The results are in compliance. The max 8 hour running average is about 40% of the EU standard

Variation

The same diurnal and seasonal pattern is experienced as for nitrogen oxides.

Discussion

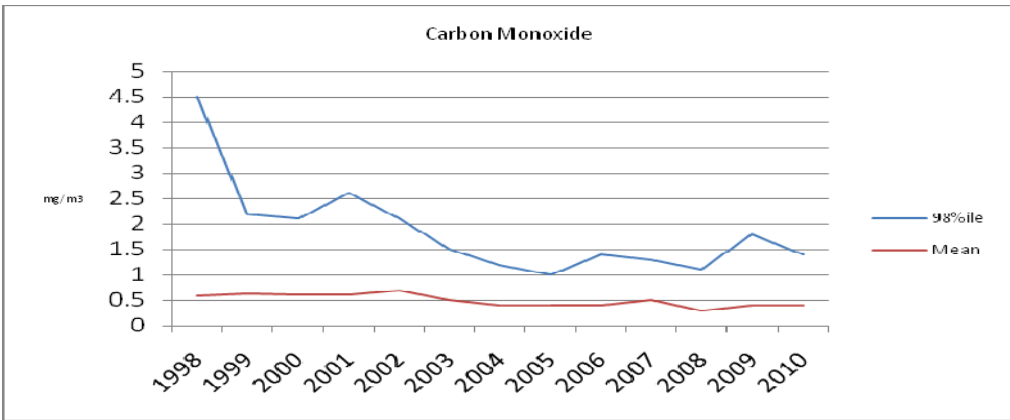
Normally the diurnal and seasonal patterns follow the same pattern as for NO₂. On the very cold frosty day of 3/12/10 with a minimum temp of -3C, the normal pattern is not followed. There is little variation through the day until nightfall when the increased fuel burning and poor dispersion increased levels substantially. At a later date, 21/12/10, an even colder day with a minimum temp of -7C. There was a slightly higher mean wind speed. The more normal pattern of morning, noon and evening peaks are present but again the night time fuel burning is obvious.



Long Term Trends

The last chart depicts the trend in the last ten years at Old Station Road (Environment Lab). Old Station Road is the small link road between Anglesea St and the South Link.

Like many other European countries, Ireland has experienced a drop in traffic pollution parameters over the last ten years.



8. Lead

Lead almost entirely arose from the anti knock agents in the old leaded petrols. The monitoring is at Old Station Road.

Results 2010 (Previous years in brackets)

The average for the year was 0.003 (0.003 (0.006) ug/m³.
The max value was 0.006 (0.006) (0.021) ug/m³.

Standards

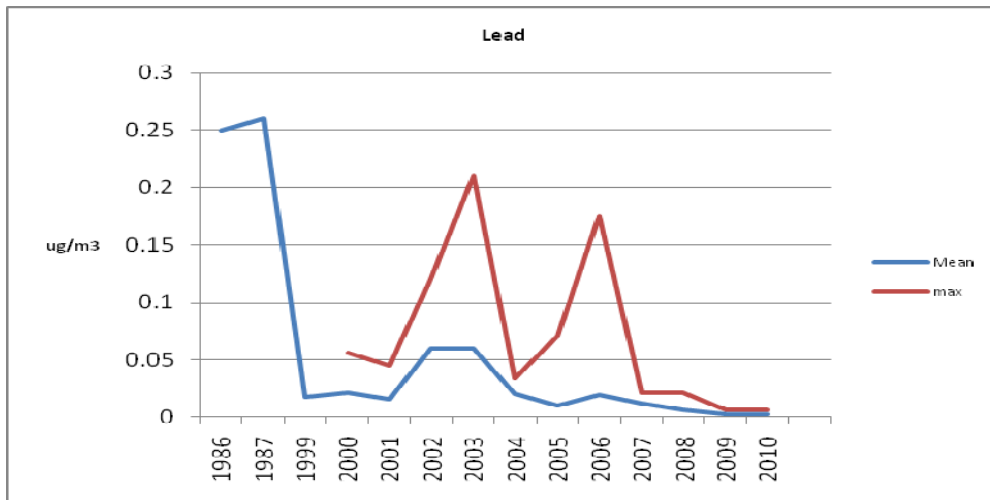
The Irish Regs require a limit of 0.5 ug/m³ (annual average).

Comparison with Standards

The average level recorded is less than 1% of the standard.

Discussion

There has been a dramatic fall in the average concentrations of lead in the air from 0.26 ug/m³ in 1985 to present day values of 0.01 ug/m³. The reduction is due to the change over to unleaded petrol. The concentrations are now so low that it is difficult to achieve accuracy with the method currently in use.



9. Benzene

Traffic is the main source. It can function as an anti knock agent in place of lead in petrol. The maximum concentration in petrol is fixed by EU Directive. Benzene is carcinogenic. A complete burn should eliminate benzene but engines are not 100% efficient. Catalytic converters improve this efficiency.

An automatic monitor using gas chromatography and PID detection was installed on 22 March 2000.

In September 2007, the Monitor broke down irreparably and the replacement was not fully operative until August 2008. Since then results are higher than those recorded from the previous instrument. It seems that the old instrument had a lot of very low or zero results that brought down the average readings. The new instrument has been subjected to a lot of checking by ET maintenance engineer and ourselves and this will continue over 2011, there are some discrepancies that need to be addressed.

Automatic Monitor Results (Previous year in brackets)

The annual mean for 2010 was 1.49 (1.37) (1.9*) (0.53) ug/m³.

*=insufficient data, new instrument

The max value was 23.2 (11.8) (13*) (15.7) ug/m³.

Comparison with Standards

The Irish Regs require a limit of 5 ug/m³ for benzene as an annual mean. There is compliance at 30% of the standard at this trafficked site.

There is no safe level of air pollution.

Discussion

The diurnal variation generally gives a similar shape to that for NO_x and the other parameters with a peak during the morning rush hour but the trend is not as consistent. Benzene is more a traffic pollution related parameter whereas NO_x is derived from both space heating and traffic.

