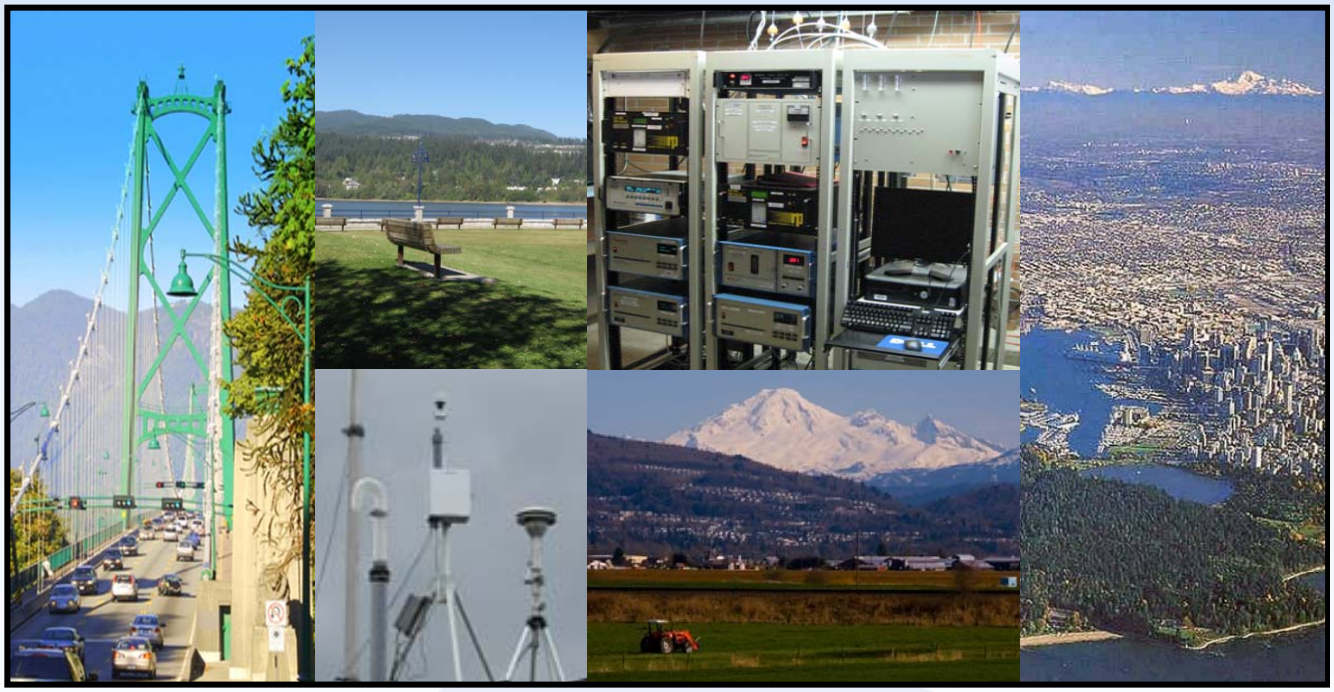
2010 Lower Fraser Valley Air Quality Summary

June 2011



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Summary

This annual report summarizes the air quality monitoring data collected by the Lower Fraser Valley (LFV) Air Quality Monitoring Network in 2010 and describes the air quality monitoring activities and programs conducted during the year. The main focus is to report on the state of ambient (outdoor) air quality in the LFV.

LFV Air Quality Monitoring Network

The LFV Air Quality Monitoring Network includes 26 air quality monitoring stations located from Horseshoe Bay in West Vancouver to Hope. Metro Vancouver operates 22 stations in Metro Vancouver, as well as 4 stations in the Fraser Valley Regional District (FVRD) under an agreement with the FVRD. In May 2010 a new monitoring station in Tsawwassen began operating as a full continuous station in the network.

Air quality and weather data from most of the stations are collected automatically on a continuous basis, transmitted to Metro Vancouver's Head Office in Burnaby, and stored in an electronic database. The data are then used to communicate air pollutant information to the public, such as through air quality health index values.

Air quality monitoring stations are located throughout the LFV to help understand the air quality levels that residents are exposed to most of the time. This report shows how these levels have varied throughout the region in 2010 and how these levels have changed over time. Trends in air quality measured by the Air Quality Monitoring Network are used to evaluate the effectiveness of pollutant emission reductions undertaken as part of Metro Vancouver's Air Quality Management Plan.

Special Air Quality Monitoring

In addition to the long-term Monitoring Network stations, Metro Vancouver deploys portable air quality stations and instruments to conduct special monitoring studies. Special studies typically investigate suspected problem areas (or "hot spots") at the local or community level, or survey potential locations for new long-term stations. In 2010, special studies were continued from the previous year(s) in New Westminster, Surrey, and in the Burrard Inlet areas of Vancouver, Burnaby and North Vancouver. In Vancouver a new wood smoke monitoring study was conducted from January to May, 2010.

Pollutants Monitored

Pollutants are emitted to the air from a variety of human activities and natural phenomena. Once airborne, the resulting pollutant concentrations are dependent on several factors, including the weather, topography and chemical reactions in the atmosphere.

Common air contaminants, including ozone (O_3), carbon monoxide (CO), sulphur dioxide (SO_2), nitrogen dioxide (NO_2), and particulate matter, are widely monitored throughout the network. Particulate matter is composed of very small particles that remain suspended in the air. They are further distinguished by their size, which is measured in units of a millionth of a metre (or micrometre). Particles with a diameter smaller than 10 micrometres are referred to as inhalable particulate (PM_{10}), while those smaller than 2.5 micrometres are termed fine particulate ($PM_{2.5}$). Both PM_{10} and $PM_{2.5}$ concentrations are monitored throughout the LFV.

Other pollutants less widely monitored in the network include ammonia, volatile organic compounds (VOC), and total reduced sulphur (TRS).

Priority Pollutants

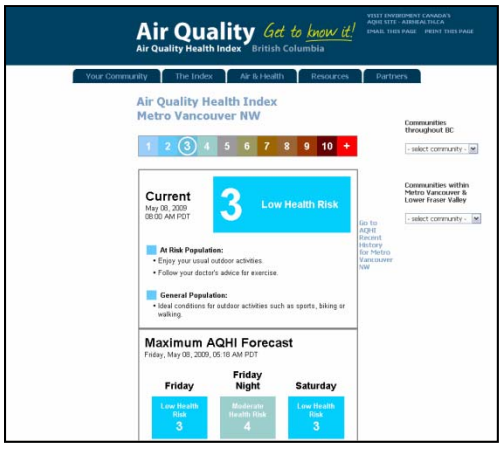
Research indicates that adverse health effects can occur at the air contaminant concentrations measured in the LFV. Health experts have identified exposure to ozone and particulate matter as being associated with the most serious health effects. Ozone is a strong oxidant that can irritate the eyes, nose and throat, and reduce lung function. $PM_{2.5}$ particles are small enough to be breathed deeply into the lungs, resulting in impacts to both respiratory and cardiovascular systems.

Long-term exposure to these pollutants can aggravate existing heart and lung diseases and lead to premature mortality.

Of particular concern is the $PM_{2.5}$ emitted from diesel fuel combustion in car, truck, marine, rail and non-road engines. These particles ("diesel PM") are thought to contribute significantly to the health effects identified above. Reducing emissions from diesel engines is a priority of Metro Vancouver's diesel emission reduction program. New instrumentation for monitoring diesel particulate is being added to the network.

Air Quality Health Index (AQHI)

The Air Quality Health Index (AQHI), developed by Environment Canada and Health Canada, has been in use since 2008. The AQHI communicates the health risks associated with a mix of air pollutants to the public and provides guidance on how individuals can adjust their exposure and physical activities as air pollution levels change. The AQHI is calculated every hour using monitoring data from stations in the LFV. Current AQHI levels in the LFV as well as the AQHI forecasts (for today, tonight and tomorrow) and additional information about the AQHI are available at:
http://www.airhealth.ca,
http://www.airhealthbc.ca, and
http://www.bcairquality.ca/readings/



Air Quality Objectives and Standards

Several pollutant-specific air quality objectives and standards are used as benchmarks to characterize air quality. They include the federal Canada-Wide Standards (for ozone and particulate matter), Metro Vancouver's ambient air quality objectives, and provincial objectives. As part of the 2005 Air Quality Management Plan, health-based ambient air quality objectives were set for ozone (O_3), particulate matter ($PM_{2.5}$ and PM_{10}), sulphur dioxide (SO_2), nitrogen dioxide (NO_2) and carbon monoxide (CO). During 2010 Metro Vancouver's objectives were more stringent than the Canada-Wide Standards and more stringent than provincial objectives, except in the case of $PM_{2.5}$.

In April 2009 the provincial government established new air quality objectives for $PM_{2.5}$. The 24-hour objective is numerically the same as Metro Vancouver's objective; however compliance with Metro Vancouver's objective requires no exceedances while the provincial objective allows for some exceedances each year. The province's annual target of 8 micrograms per cubic metre and annual planning goal of 6 micrograms per cubic metre are more stringent than the annual objective previously set by Metro Vancouver.

Air Quality Advisories

Periods of degraded air quality can occur in the LFV for several reasons, such as summertime smog during hot weather or smoke from forest fires. Air quality advisories are issued to the public and health authorities when air quality has deteriorated or is predicted to deteriorate significantly within the LFV. In the last ten years, the number of days when air quality advisories were in place ranged from zero to as many as ten days annually.

Two air quality advisories were issued in 2010, both in August. On August 4 an advisory was issued for four days and on August 16 a second advisory was issued for three days. Both advisories were due to elevated $PM_{2.5}$ concentrations as a result of smoke from forest fires outside the Lower Fraser Valley.

Visual Air Quality

Visual air quality (also known as visibility and haze) can also be degraded in the LFV, causing local views to become partially obscured. This haze may have different characteristics depending on the location. In much of Metro Vancouver, especially the more urbanized areas to the west, the haze can have a brownish appearance due to emissions of nitrogen oxides from transportation sources. Further east in the LFV impaired visibility is often associated with a white haze, which is due to small particles ($PM_{2.5}$) in the air that scatter light.

Monitoring conducted for assessing visibility and haze includes continuous measurements of ammonia, $PM_{2.5}$ and important constituents (for example, particulate nitrate, particulate sulphate, elemental carbon and organic carbon) and light scattering. Seven automated digital cameras are also operated throughout the LFV to record views along specific lines of sight. When these photographs are examined alongside the pollutant measurements, visibility impairment can be related to pollution concentrations and their sources. New visibility monitoring instruments are being considered as part of a multi-agency initiative to develop a pilot visibility improvement strategy for the LFV.

Regional Trends in Air Quality

Long-term *regional* trends in air quality are the trends observed within the LFV as a whole. They are determined by averaging measurements from several stations distributed throughout the LFV.

Figures S1 to S4 show the average concentrations and the short-term peak concentrations of four common air contaminants for the last two decades. Average concentrations represent the ambient concentrations that the region experiences most of the time. Short-term peak concentrations show the relatively infrequent higher concentrations experienced for short periods (on the scale of one hour to one day). Specific locations may have experienced trends that differ slightly from the regional picture.

Figure S1: Nitrogen Dioxide Trends

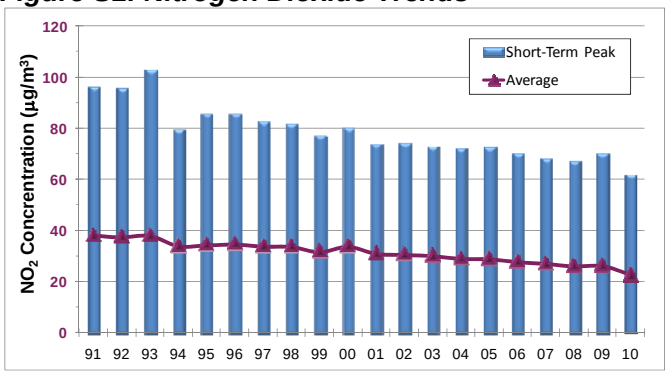


Figure S2: Sulphur Dioxide Trends

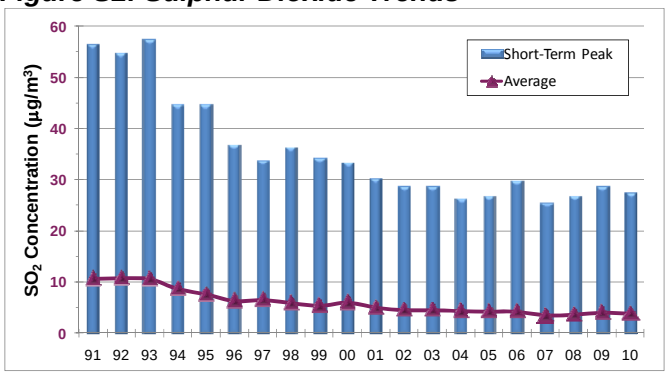


Figure S3: Carbon Monoxide Trends

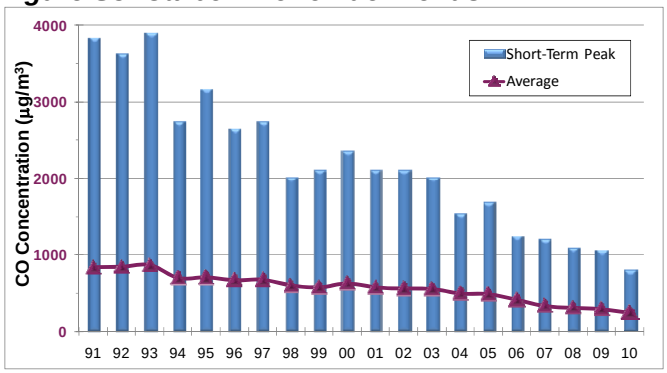
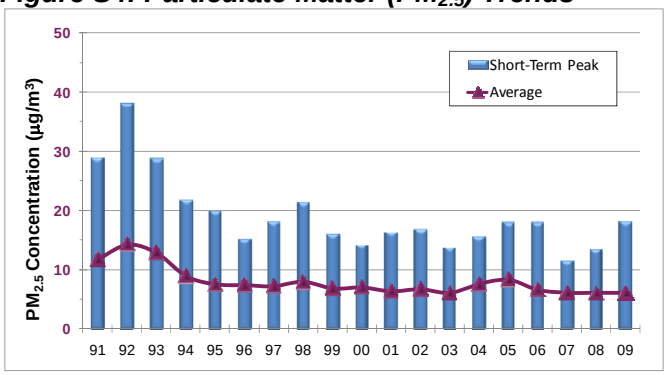


Figure S4: Particulate Matter ($PM_{2.5}$) Trends



Improvements have been made over the last two decades for some pollutants, including carbon monoxide (CO), nitrogen dioxide (NO_2), sulphur dioxide (SO_2) and particulate matter ($PM_{2.5}$). Both short-term peak and average concentrations have declined since the early nineties for all these pollutants.

Despite significant population growth in the region over the same time period, emission reductions across a variety of sectors have brought about these improvements. Improved vehicle emission standards and the AirCare program are largely responsible for lower carbon monoxide (CO) and nitrogen dioxide (NO_2) levels.

Reduced sulphur in on-road fuels, the shutdown of several refineries in Metro Vancouver and reduced emissions from the cement industry have led to the measured reductions in sulphur dioxide (SO_2) levels. Emission reductions from wood products sectors, petroleum refining, and vehicles have contributed to the decline in $PM_{2.5}$ levels. In recent years, peak and average levels of carbon monoxide (CO) and nitrogen dioxide (NO_2) have continued to decline, while it appears that both sulphur dioxide (SO_2) and particulate matter ($PM_{2.5}$) may be levelling off.

Note that Figure S4 shows long-term $PM_{2.5}$ trends from a single monitoring station with a long record of non-continuous filter-based monitoring (Port Moody). The regional $PM_{2.5}$ trends since 2001, when continuous $PM_{2.5}$ monitoring was more prevalent throughout the LFV, are illustrated in Figure S5. These data also indicate that $PM_{2.5}$ peak levels have been relatively constant in recent years, although with some year-to-year variability.

For ozone, the same improvements seen for other pollutants have not been observed. In contrast, average regional ozone levels (Figure S6) have been increasing in the most recent 15 years. Research suggests that background ozone concentrations may be rising and could be a potential reason for the observed increase in average levels.

Regionally averaged short-term peak ozone trends are shown in Figure S6 and display year to year variability. The severity of ozone episodes greatly diminished in the 1980s, however short-term peak zone levels have been mainly unchanged during the last two decades, despite large reductions in emissions of pollutants that contribute to ozone formation.

Figure S5: $PM_{2.5}$ Trends

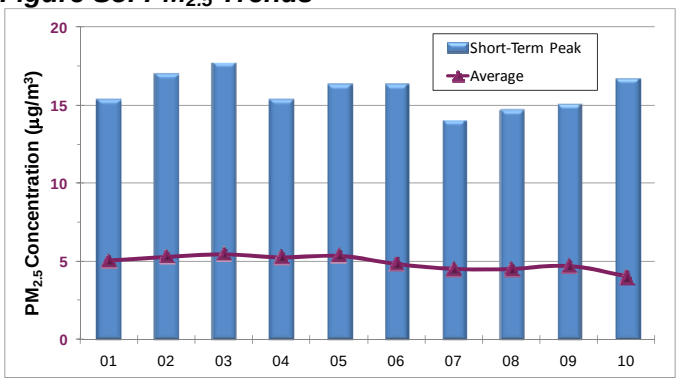
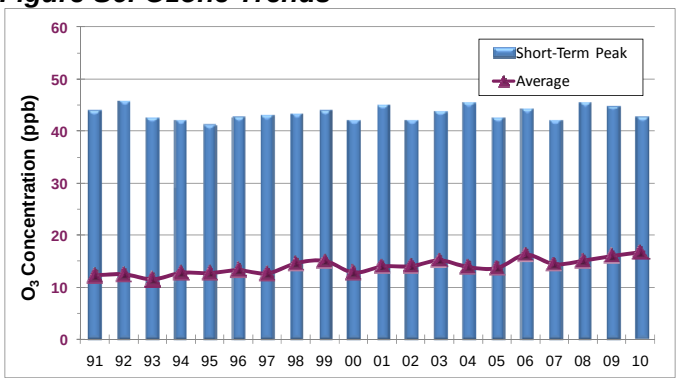


Figure S6: Ozone Trends



On-going research indicates that the highest ozone levels are occurring in the eastern parts of the LFV and that the location of the maximum has shifted eastward over time. A study led by UBC researchers was initiated in 2009 to better understand ozone in the LFV and to suggest the most effective strategies to help improve ozone levels.

Ozone Air Quality – 2010

Monitoring results for all ozone monitoring stations in 2010 are shown in Figure S7. The data show that peak ozone levels, as measured by the Canada-Wide Standard and maximum 8-hour average values, occurred in the eastern parts of Metro Vancouver and in the FVRD during sunny and hot weather.

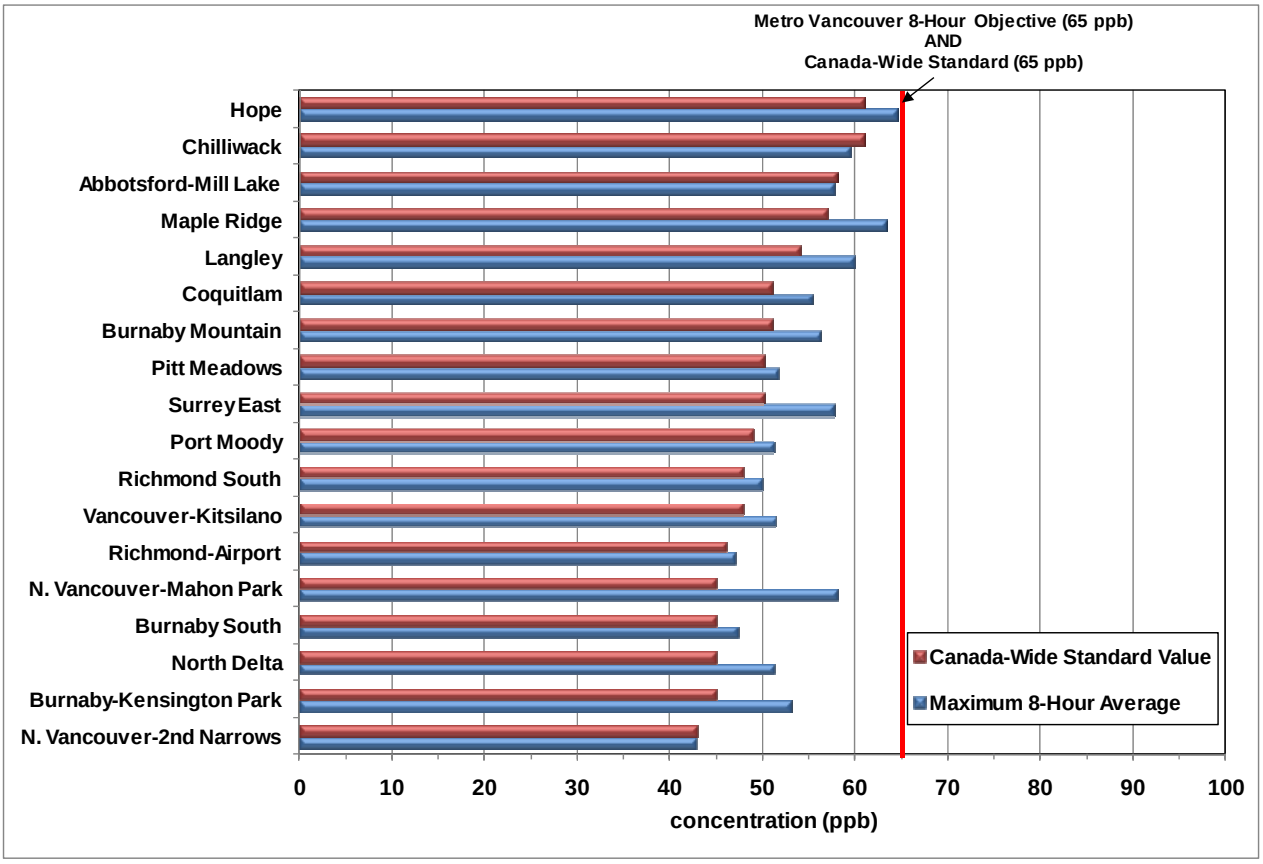
In 2010 the Canada-Wide Standard for ozone was met at all monitoring stations. Metro Vancouver's more stringent ozone objective was also met in 2010 for the first time in ten years. Exceedances of this objective have occurred in the Lower Fraser Valley every year for the previous 9 years.

No air quality advisories were issued for ozone in 2010.

Ozone is termed a secondary pollutant because it is formed in the air from other contaminants such as nitrogen oxides (NO_X) and volatile organic compounds (VOC). The highest concentrations of ozone are generally formed during hot sunny weather.

NO_X emissions are dominated by transportation sources, with nearly 80% of the emissions coming from cars, trucks, marine vessels, and non-road engines. VOC are emitted from natural sources, cars, light trucks, and solvent evaporation from industrial, commercial and consumer products.

Figure S7: Ozone (O_3) 2010



Particulate Matter Air Quality – 2010

Monitoring results for all $PM_{2.5}$ monitoring stations in 2010 are shown in Figure S8. All stations with sufficient data requirements met the provincial annual objective of 8 micrograms per cubic metre and the annual planning goal of 6 micrograms per cubic metre. In addition, all locations were well below the Canada-wide Standard for $PM_{2.5}$. Insufficient $PM_{2.5}$ data were available for Horseshoe Bay and Port Moody in 2010 to calculate the Canada-Wide Standard.

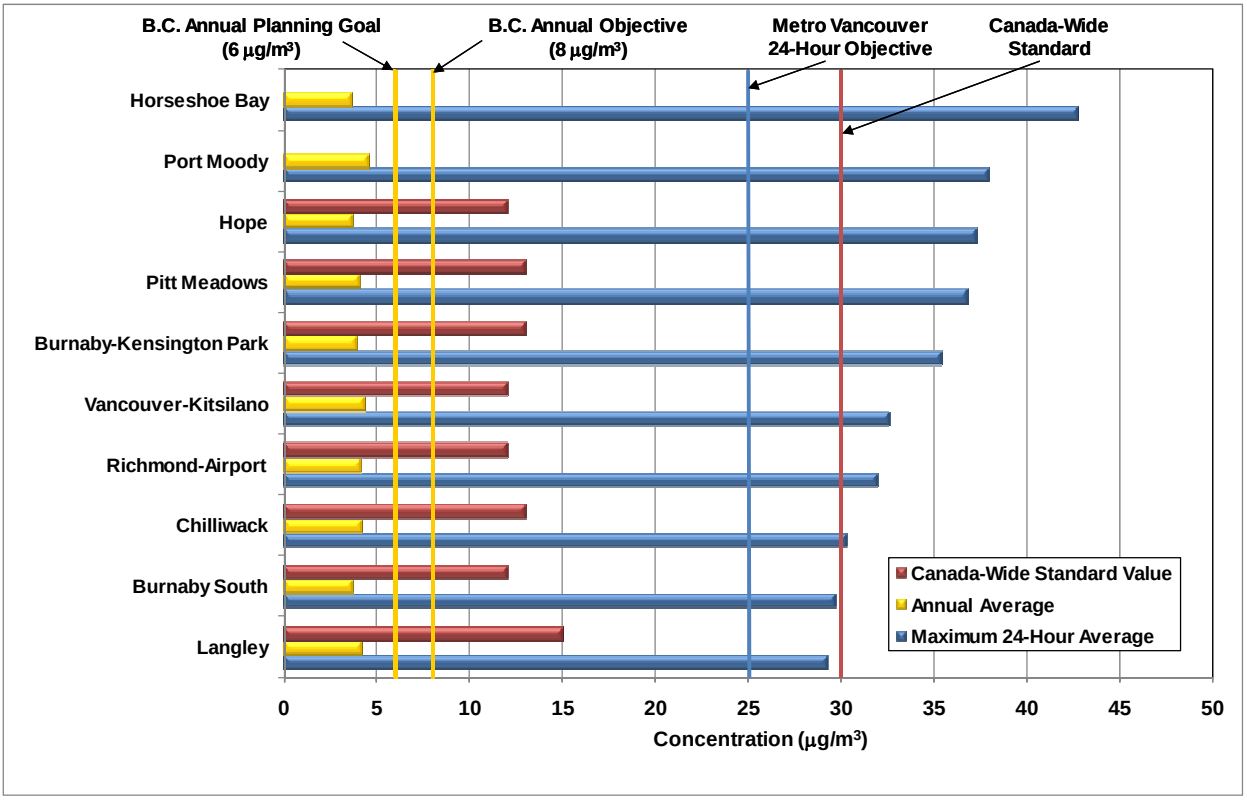
There were exceedances of Metro Vancouver's 24-hour $PM_{2.5}$ objective at all stations that measured $PM_{2.5}$ in August 2010. Exceedances occurred during two periods in August (4 to 6 and 15 to 17) when smoke from forest fires was transported to the Lower Fraser Valley. Air quality advisories were issued by Metro Vancouver during both periods. On August 4, rising $PM_{2.5}$ was detected at Hope, with the majority of stations in the LFV reporting exceedances the next day. Several stations exceeded the 24-hour objective until the evening of August 6.

$PM_{2.5}$ emissions are dominated by transportation, space heating, and industrial sources. $PM_{2.5}$ is also formed by reactions of nitrogen oxides (NO_X) and sulphur dioxide (SO_2) with ammonia in the air. $PM_{2.5}$ produced in this manner is called secondary $PM_{2.5}$ and accounts for a significant percentage of $PM_{2.5}$ in summer.

Late in the evening on August 15 $PM_{2.5}$ exceedances were measured at the new Tsawwassen station with exceedances also occurring the next morning at the Richmond Airport and Kitsilano stations. By August 17 $PM_{2.5}$ concentrations decreased below the Metro Vancouver 24-hour $PM_{2.5}$ objective. Note that the Tsawwassen station is not shown in Figure S8 as the data completeness requirements were not met.

$PM_{2.5}$ can be transported long distances in the atmosphere. The many forest fires that occurred in B.C. in the summer of 2010 contributed to elevated concentrations of $PM_{2.5}$ in the Lower Fraser Valley.

Figure S8: Particulate Matter ($PM_{2.5}$) 2010



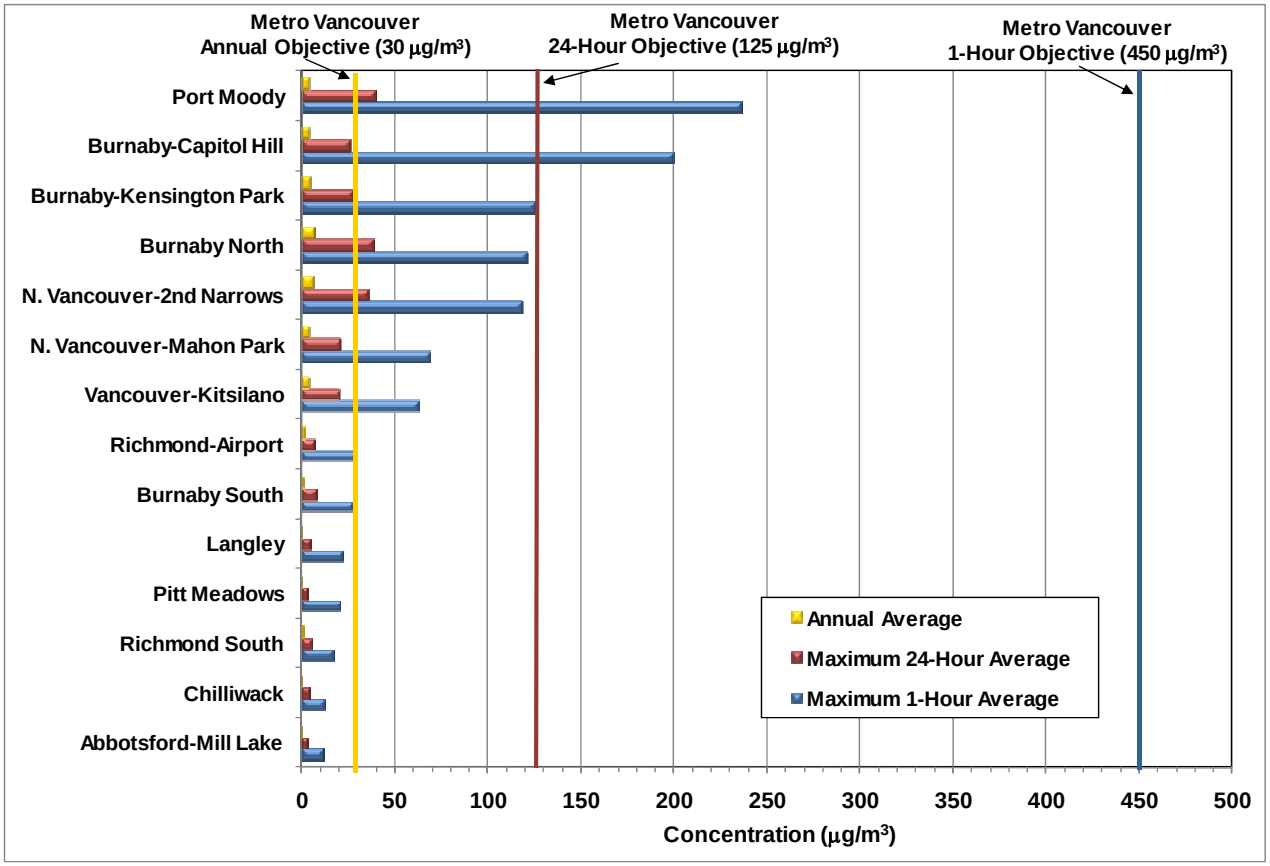
Sulphur Dioxide Air Quality – 2010

Monitoring results for all sulphur dioxide (SO_2) monitoring stations in 2010 are shown in Figure S9. Objectives for sulphur dioxide were met at all stations at all times.

Sulphur dioxide is formed primarily by the combustion of fossil fuels containing sulphur. The largest sources in the LFV are marine vessels (mainly ocean-going vessels) and the petroleum products industry. As a result, highest sulphur dioxide levels are typically recorded near the Burrard Inlet area. Away from the Burrard Inlet area, sulphur dioxide levels are much lower.

Sulphur dioxide contributes to secondary $PM_{2.5}$ formation.

Figure S9: Sulphur Dioxide (SO_2) 2010



Nitrogen Dioxide Air Quality – 2010

Monitoring results for all nitrogen dioxide (NO_2) monitoring stations in 2010 are shown in Figure S10. All 1-hour nitrogen dioxide averages were below Metro Vancouver's objective. Average levels also met Metro Vancouver's annual objective at all stations with sufficient data completeness. In recent years the highest average nitrogen dioxide levels were measured in downtown Vancouver, in a dense urban environment and close to a busy street. Figure S10 does not include data from this station due to a temporary shut down during most of 2010.

As nitrogen dioxide emissions are dominated by transportation sources, the highest average nitrogen dioxide concentrations are measured in the more densely trafficked areas and near busy roads. Lower concentrations are observed where these influences are less pronounced, such as the eastern parts of Metro Vancouver and in the FVRD.

Carbon Monoxide Air Quality – 2010

Carbon monoxide levels met all of the relevant Metro Vancouver air quality objectives at all stations throughout the LFV (not shown). The principle source of carbon monoxide continues to be emissions from motor vehicles. Higher concentrations generally occur close to major roads during peak traffic periods. Like nitrogen dioxide, the highest average carbon monoxide concentrations are measured in the more densely trafficked areas and near busy roads. Lower concentrations are observed where these influences are less pronounced, such as the eastern parts of Metro Vancouver and in the FVRD.

Figure S10: Nitrogen Dioxide (NO_2) 2010