BRITISH COLUMBIA

STATE OF THE AIR 2012

Celebrating the Clean Air Month of June

FOREWORD

We are especially thrilled to present the 2012 State of the Air Report. This year, we have not one but two Clean Air Champions: the Prince George Air Improvement Roundtable (PGAIR) and Dana Schmidt. While PGAIR has done a lot over the years to protect and ensure clean air quality for the community of Prince George, Dana Schmidt founded the Donna Schmidt Memorial Lung Cancer Prevention Society three years ago to educate Castlegar's residents on the dangers and health effects of radon exposure in homes.

In this issue, we also profile two very special individuals: triathlete Jeff Symonds and rugby player Andrea Burk. Though competing in two different sports, Jeff and Andrea battle the same illness: asthma. Their stories of courage and determination should inspire and remind others living with asthma that it is possible to stay active and to succeed.

Like in previous years, we provide updates on air quality, air pollution levels in B.C. compared to other parts of Canada, and the clean air initiatives that agencies at various levels of government are undertaking. We also turn our attention on two emerging issues—ultrafine particles and traffic-related air pollution—and report on our 9th Annual Air Quality and Health Workshop held last March.

Preparing a report such as this takes a lot of time and energy, and I thank everyone who tirelessly worked to get it done.

SCOTT MCDONALD
President and CEO
BC Lung Association

CONTENTS

Triumph Over Adversity

Two incredibly inspiring athletes, one shared illness—this is the focus of this year's **PROFILE**. Through the stories of Jeff Symonds and Andrea Burk, we find out how asthma affects athletes during training and competition. We also discover how a positive outlook and courage help Jeff and Andrea overcome adversity, something from which their fellow asthmatic athletes can learn so much.

Jeff Symonds: Professional Triathlete

Penticton's Jeff Symonds grew up playing "a ton of sports." While attending the University of British Columbia, he participated in track and cross-country events, eventually developing a passion for competing in triathlons. "Triathlons are definitely endurance events," he reflects. "It's all about who can push the longest."

Today, Jeff is one of Canada's top Ironman 70.3 athletes. The 70.3, dubbed the Half Ironman, is a gruelling triathlon race consisting of a 1.9-km swim, followed by a 90-km bicycle ride and a 21.1-km run. Jeff estimates that he participates in about 25 events a year—or one event every other week—which include 10 major competitions and over a dozen shorter ones.

"A lot more athletes than you'd expect have asthma. With proper treatment, any asthmatic athlete can succeed."

While many don't think about the importance of breathing efficiently, it holds special importance to someone like Jeff who has asthma. "Breathing is huge," he is quick to point out. "Competing in endurance events is a lot about getting oxygen into your muscles, of staying as efficient as possible. If you can't keep breathing calmly, it will affect your whole body. You're going to have a tough day."

Jeff's asthma wasn't diagnosed until he was 18. While competing in cross-country events at UBC, he started experiencing breathing difficulties and tired out easily. At first he thought it was due to physical exertion, but when his colleagues started noticing that he wheezed while running, Jeff finally decided to get himself checked.

"I was diagnosed and given medication to control my asthma," he narrates. "After that, my performance levelled out." Though not severe, Jeff's asthma can drain him when he's competing. "If I'm wheezing, it's harder to breathe—air is not getting in. When I'm swimming, I have difficulty taking deep breaths, so I get fatigued."

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WHY DO WE CARE ABOUT AIR QUALITY?

asthma and the environment

Asthma is a chronic lung disease affecting hundreds of thousands of children and adults in British Columbia. People with asthma have very sensitive airways that are easily irritated when they inhale certain substances. When irritated, the airways become inflamed, leading to symptoms like wheezing, coughing, chest tightness, and shortness of breath.

> There is no cure for asthma, but current knowledge and treatments allow most asthmatics to live normal, active lives while managing the disease.

In most cases, asthma symptoms are mild and readily controlled by rescue medications. However, sometimes they escalate into a full-blown and potentially life-threatening asthma attack. There is no cure for asthma, but current knowledge and treatments allow most asthmatics to live normal, active lives while managing the disease.

On March 6, 2012, the BC Lung Association hosted the 9th Annual Air Quality and Health Workshop on the subject. A group of 12 local and international experts were gathered to share their knowledge of the disease, and to describe how a wide variety of factors can affect people living with asthma.

Highlights included:

- The increase in the number of people living with asthma over the recent decades, adding to health care cost
- Challenges to asthma management, including the role of genetics and the environment in the development of asthma
- The effects of irritants such as outdoor air pollution, climate change, tobacco smoke, pollens, moulds, and cleaning agents
- Valuable online tools for people living with asthma—namely, the Air Quality Health Index and BlueSky smoke forecasting system

Podcasts of all presentations are available online at www.BC.Lung.ca. Planning for the 2013 Air Quality and Health Workshop on "Ultrafine Particles and its Health Impacts" is underway, and details will be available from the BC Lung Association soon.

Andrea Burk: Rugby Player

Andrea Burk is an athlete who competes for Canada on the Women's Rugby 7s and 15s teams. She began playing rugby in Grade 10. Today, at age 30, Andrea continues to train five hours daily for a sport that has taken her to tournaments all over the world. "Every couple months," she says, "there's a tournament in which teams might play five games in a day."

Rugby is a physically demanding sport requiring strength, speed and agility. Rugby 7s, played with seven players on each side, is particularly fast and demands aerobic fitness. The sport would be challenging to even the most physically fit, but Andrea's achievements are especially remarkable because she has asthma.

"I have mild to moderate asthma," she shares. "I was diagnosed when I was 11. When I have an asthma attack, my chest feels tight. I feel like I'm breathing through a straw, and occasionally I get lightheaded due to lack of oxygen. Though I've never been hospitalized due to my asthma, I know my lungs don't function as well as a regular person's."

Because poor air quality can trigger her asthma, Andrea feels very fortunate to be living on B.C.'s West Coast where air quality is relatively good. "I

(Cont'd on p. 4)

(**Jeff Symonds**... cont'd from p. 3)

Of triathlon's three events, Jeff finds swimming the biggest challenge to his breathing. "Much of it has to do with chemicals in the pool—of breathing in chlorine," Jeff explains. "I find that swimming in pools is tougher, especially if I forget to take my medication."

Today, Jeff does most of his training in Penticton. "Air quality there is great," he says, "except during the fire season. When that starts and I notice air quality declining, I make sure I take my medication. I can't really control air quality—and air quality and terrain definitely affect how hard I push myself. So when I have issues with breathing, I simply go slower."

Jeff is looking forward to competing this summer locally and nationally, and he offers this advice to other young athletes with asthma: "A lot more athletes than you'd expect have asthma, but with proper treatment, you can succeed."

(**Andrea Burk**... cont'd from p. 4)

can go for months training and exercising at home, with my lungs getting stronger," she says.

Outdoor air pollution affects Andrea's ability to breathe freely, but indoor air quality can be just as problematic for her. As she explains: "If the air is dry or there's something in the air—dust, certain strong smells, cigarette smoke—my asthma can get triggered."

Through the years, Andrea has learned to cope with air pollutants. "It's important for me to be aware of the air quality," she reflects, "and to be prepared—which means having my medication all the time. I could be walking to a venue feeling fine, only to get wheezy when I start my warm-ups."

Andrea recognizes how critical breathing is to competing at full capacity. "I'm always prepared," she says, "so I've never reached a point where I've had to be removed from a game."

Besides being prepared, Andrea's ability to be in tune with her body has helped her successfully manage her asthma. "When I hear myself wheezing, I speak encouragingly to myself. I remind myself that I've been through this before, and that I'll get through it again. Sometimes, this is enough to calm down the attack and I won't need my inhaler."

"It's very possible to stay active with asthma. I'm happy where I am today. My dream is coming true!"


COLIN WATSON

Asthma certainly hasn't slowed Andrea down one bit. There is no stopping her as she prepares to compete nationally and internationally in the game she loves the most.

She remains positive and cheerful, her optimism reflected in her words: "I don't let my asthma limit me. And I would tell asthmatic kids who are into sports to not let their asthma stop them, too. It's very possible to stay active with asthma. I'm happy where I am. This has been a dream for me—and it's all coming true!"

What's in the air we breathe?

Pollutant	Description	Sources	Human Health Effects	Environmental Effects
Particulate Matter (PM)	Microscopic solid and liquid particles that are suspended in the atmosphere; PM_{10} refers to particles 10 micrometres and smaller and $PM_{2.5}$ to particles 2.5 micrometres or smaller	Fuel combustion (including wood and diesel), industrial processes, agriculture, unpaved roads, and reactions in the atmosphere involving NOx, SO_2, hydrocarbons and ammonia	Aggravation of respiratory and cardiovascular disease, reduced lung function, increased respiratory symptoms and premature death	Impairment of visibility, effects on climate, and damage and/or discolouration of structures and property
Ozone	Very reactive oxygen species; in the upper atmosphere, ozone shields earth from sun's harmful ultraviolet rays	Formed in the atmosphere from reactions involving NOx and hydrocarbons in the presence of sunlight	Aggravation of respiratory and cardiovascular disease, decreased lung function and increased respiratory symptoms, increased susceptibility to respiratory infection and premature death	Damage to vegetation, such as impacts on tree growth and reduced crop yields
Nitrogen Oxides (NOx)	Group of highly reactive gases that include nitric oxide (NO) and nitrogen dioxide (NO_2); NO_2 is odorous, brown and highly corrosive	High-temperature combustion sources, such as transportation and industry	Aggravation of respiratory disease and increased susceptibility to respiratory infections; contributes to ozone and PM formation with associated health effects	Contributes to acidification and nutrient enrichment (eutrophication, nitrogen saturation) of soil and surface water; contributes to ozone and PM formation with associated environmental effects
Sulphur Dioxide (SO_2)	Colourless gas with pungent odour that smells like a struck match	Burning of sulphur-containing fossil fuels and processing of sulphur-containing ores	Aggravation of asthma and increased respiratory symptoms; contributes to PM formation with associated health effects	Contributes to acidification of soil and surface water and mercury methylation in wetland areas; contributes to PM formation with associated environmental effects

Based on: U.S. Environmental Protection Agency (2008) National Air Quality Status and Trends Through 2007. Report EPA-454/R-08-006, U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, Air Quality Assessment Division, Research Triangle Park, North Carolina, November 2008.

POLLUTION LEVELS: How does BC measure up?

The Ministry of Environment and—within the Lower Fraser Valley—Metro Vancouver and FVRD operate an extensive monitoring network to track levels of common air pollutants in B.C. communities. These pollutants include fine particulate matter, ground-level ozone, nitrogen dioxide, and sulphur dioxide.

Fine Particulate Matter ($PM_{2.5}$). Figure 1 shows annual average concentrations of $PM_{2.5}$ measured at continuous (TEOM) monitoring sites in 2011. The highest concentrations were observed in interior communities such as Quesnel (6.3 µg/m³), Golden (6 µg/m³), and Grand Forks (5.8 µg/m³), with peak levels occurring in the fall and winter. None of these sites exceeded the provincial annual objective of 8 µg/m³ or the 24-hour objective of 25 µg/m³. However, data from the past three years show that monitoring sites in both Quesnel and Williams Lake exceeded the Canada-wide Standards for $PM_{2.5}$ of 30 µg/m³ due largely to the influence of wildfires in 2010.

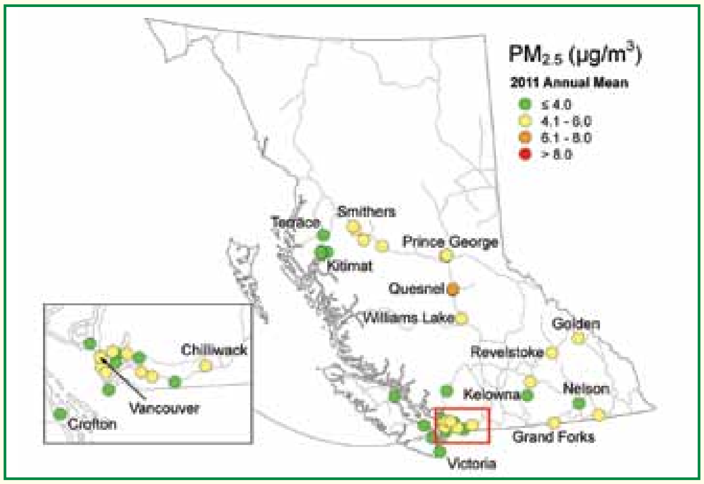

Fig. 1: Ambient mean $PM_{2.5}$ concentrations in µg/m³ for 2011. Data shown reflects TEOM or TEOM-compatible measurements from continuous samplers.

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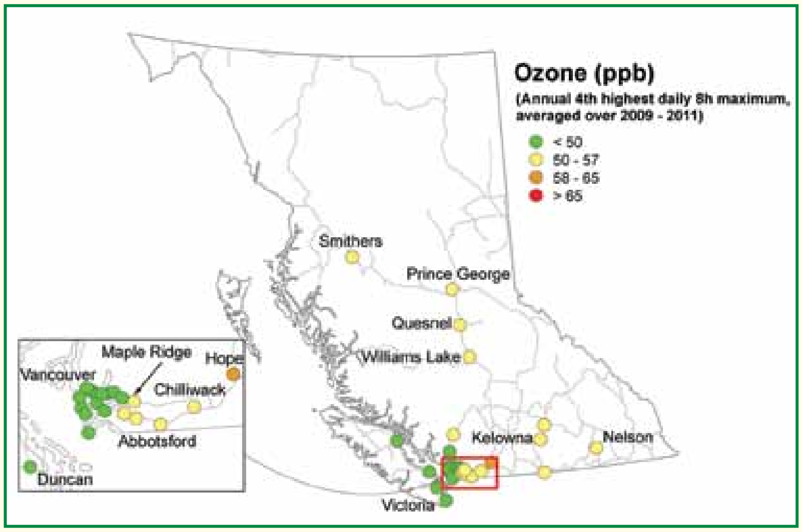
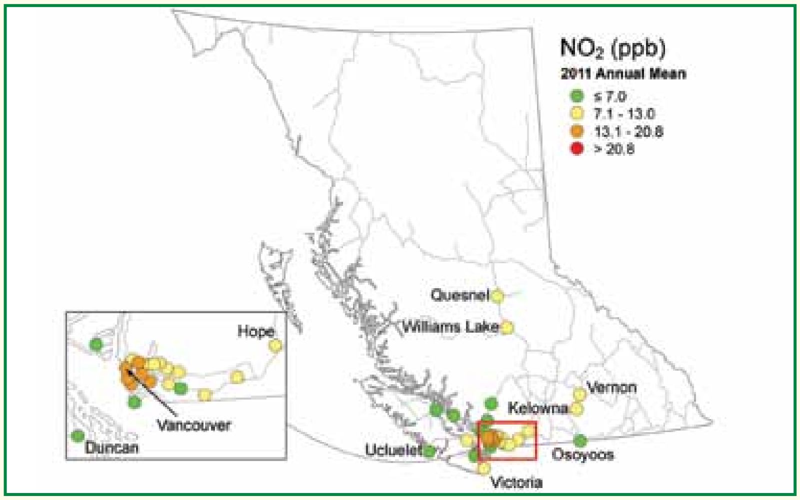
(***B.C. Pollution Levels***... *cont'd from p. 5)*



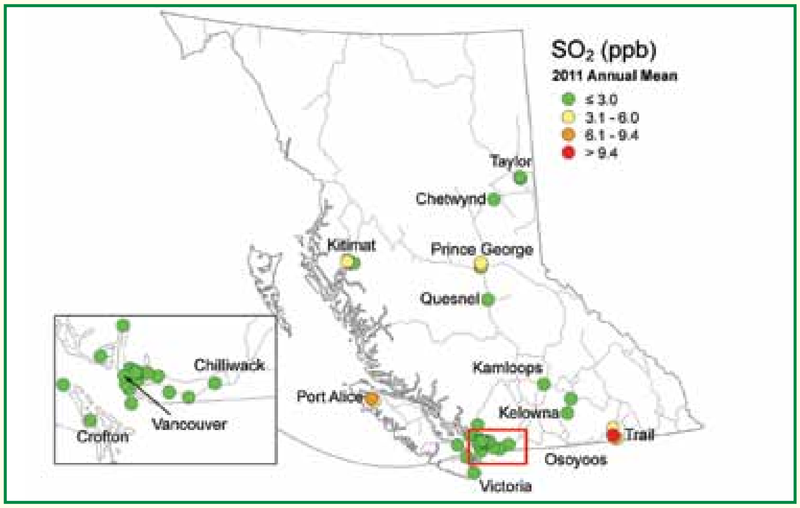
Ground-level Ozone (O_3). Figure 2 summarizes O_3 concentrations, which typically peak in the summer months when conditions are warm and sunny. In 2011, no B.C. monitoring sites exceeded the Canada-wide Standard of 65 ppb. The highest concentrations were observed in the eastern Fraser Valley, in Hope (58 ppb), Chilliwack (56 ppb), Abbotsford (55 ppb), and Maple Ridge (55 ppb). The lowest concentrations were found in western parts of Metro Vancouver.

Fig. 2: Annual average O_3 concentrations in ppb based on the eight-hour daily maximum concentrations (annual 4th highest averaged over 2009 to 2011).



Nitrogen Dioxide (NO_2). Figure 3 summarizes annual average NO_2 concentrations in 2011. Concentrations were well below both the national (~31 ppb) and Metro Vancouver (~21 ppb) objectives. Average concentrations ranged from 1 ppb in Ucluelet (a background site) to almost 17 ppb in Vancouver. In general, the highest concentrations were found in Metro Vancouver—in areas close to major traffic corridors or transportation hubs—during the fall and winter months.

Fig. 3: Annual mean NO_2 concentrations in ppb for 2011.



Sulphur Dioxide (SO_2). Annual average SO_2 concentrations in 2011 (see Figure 4) ranged from less than 1 ppb in a handful of communities to a high of 12.8 ppb in Warfield (near Trail), which exceeded the provincial objective of about 9.4 ppb. Short-term concentrations in excess of about 170 ppb were observed at several sites in Trail, Port Alice and Prince George, each of which was in close proximity to major industrial sources such as smelters, pulp and paper mills, and petroleum refineries.

Fig. 4. Annual mean SO_2 concentrations in ppb for 2011.

CLEANING UP THE NEIGHBOURHOOD: Reducing Exposure to Traffic Emissions

Internal combustion engines in cars and trucks emit a myriad of different gases and particles. A growing body of scientific evidence links traffic-related air pollution (TRAP) to human health.

Scientists at the University of British Columbia recently reviewed local and international studies on the health effects and public health implications of traffic-related air pollution; reviewed legislation and guidelines on urban planning, the built environment and traffic exposure; and identified options to reduce human exposure to TRAP. The following summarizes their key findings:

TRAP has become a public health concern due to the large percentage of Canadians exposed to it. Approximately one-third of all Canadians live within 100 metres of a major road or 500 metres of a highway—the zones most greatly affected by TRAP. Of this population, approximately 20% live within 50 metres of a major road. Nearly one-third of elementary schools in Canadian cities are located in high-traffic areas. In short, those who live, work, exercise or commute near major roads are exposed to increased levels of TRAP that may affect their health.

Four general approaches have been identified to reduce TRAP exposure:

* Land-use planning and transportation management—e.g., through the siting of new buildings and roads, road setbacks, the separation of motorized from active transportation modes
* Vehicle emission reduction—e.g., via new vehicle emission regulations, fuel quality standards, inspection and maintenance programs for existing fleets
* Existing structure modification—e.g., through outdoor measures such as physical barriers and the separation of bicycle lanes from traffic, and indoor measures such as air filtration
* Encouraging behaviour change—e.g., by offering alternatives to private vehicles such as car-sharing and improved public transport, and educating people on how transportation choices impact emissions and TRAP exposure

A cohesive strategy to reduce TRAP exposure will consist of various actions with both short- and long-term benefits, especially for susceptible sub-populations. Actions with potential short-term (months to years) benefits include:

* Installing HVAC filter systems in buildings that house susceptible populations within 150 metres of busy roads—i.e., >15,000 AADT (annual average daily traffic)
* Limiting heavy truck traffic to specific routes and times
* Vehicle inspection and maintenance programs to identify high emitting vehicles requiring retrofitting or removal
* Separating active commuting (e.g., cycling) from busy roads
* Anti-idling bylaws
* Traffic congestion reduction policies—e.g., tolls, parking restrictions, low emission zones, car-share programs, and increased public transportation

Actions expected to provide longer term (years to decades) benefits include land use planning that incorporates health impact assessments as well as the siting of buildings that house susceptible populations, such as schools, daycare and retirement homes at least 150 metres from busy roads.

Some of these measures have already been incorporated into B.C.'s "Develop with Care" guidelines (www.Env.Gov.BC.ca/wld/Documents/bmp/DevWithCare2012/), which identify best-management practices to protect environmental values. The California Air Resources Board (CARB) also offers a useful reference guide for evaluating and reducing air pollution impacts associated with new projects that go through the land-use decision-making process (see: www.ARB.ca.gov/ch/LandUse.htm).

As part of efforts to explain the health effects associated with exposure to particulate air pollution, one proposed mechanism focuses on the very smallest particles—ultrafine particles (UFP), with a diameter smaller than 0.1 micrometre. While making relatively minor contributions to the mass concentrations traditionally measured, these particles comprise the vast majority of airborne particles by number.

UFP exist in large numbers and make up a large surface area, arguably a parameter more relevant to toxicity than mass. As well, their minute size allows them to cross into the bloodstream, through which they can impact the body more easily.

Concern for UFP partly grew out of the increasing widespread use of specific vehicle technologies, such as gasoline direct injection. UFP are not routinely measured by ambient air quality management agencies, but for the past 15 years there has been extensive research into the toxicology, exposure to and epidemiology of UFP in ambient air, and a general understanding has begun to emerge.

Recently, the Health Effects Institute (HEI), a non-profit research organization dedicated to providing high-quality, impartial, and relevant science on air pollution's health effects, commissioned a panel of experts to evaluate evidence of UFP emissions from motor vehicles. The review aimed to address two questions:

1. How much do mobile sources contribute to human exposure to ambient UFP?

2. Do UFP affect human health at environmental concentrations?

To address these questions, emissions and exposure research, experimental

animal and clinical studies, and epidemiologic investigations were reviewed. Preliminary conclusions of the panel's report were presented at the HEI Annual Conference (www.HealthEffects.org/Slides/AnnConf2012/), and findings relevant to British Columbia are briefly summarized here:

While UFP emissions have numerous sources, motor vehicles, especially older diesel vehicles, are the primary source in urban areas. To address this, Europe set particle number emissions limits for all diesel vehicles. These limits ensure that diesel particle filters (DPFs) are installed on all diesel vehicles. A particle number standard for gasoline cars is currently being studied.

North America has not adopted these emissions standards, though they will affect imported European vehicles. The California Air Resources Board is considering an optional particle standard as it implements Low-Emission Vehicle regulations for light- and medium-duty vehicles.

Diesel particle filters, which are now required on all new diesel vehicles, have proven to be effective in dramatically reducing UFP emissions (by 99% and 95% for particle number and mass, respectively).

However, the same filters increase the emissions of very fine sulphate particles. They are also subject to emissions from periodic filter regeneration (when particles trapped by the filters are burned off), which may contribute to high, short-term concentrations of UFP.

Emissions from small gasoline engines (the type found in mopeds and scooters) and from off-road vehicles and machinery (construction equipment, marine vessels, diesel backup power generators) may also be significant sources of UFP emissions. Under specific conditions, wood combustion, space heating and emissions from cooking can also be important sources.

A recent study by the University of British Columbia established that motor vehicles are the leading source of UFP emissions in urban areas. In measuring UFP in 80 different sites in the Lower Fraser Valley, the study found higher concentrations at locations closest to major roads (see Figures 5 and 6).

The measurements obtained were further used to develop a spatial model of UFP concentrations for the region (see Figure 5). Factors determining spatial variability in UFP counts were identified as follows: the density of truck routes (within 50 metres), the proximity to ports, and the number of restaurants with frying/grilling found within 200 metres of the locations of measurements.

Given motor vehicles' huge effect on UFP concentrations, it is hardly surprising that time spent in proximity to motor vehicles (i.e., in traffic) greatly

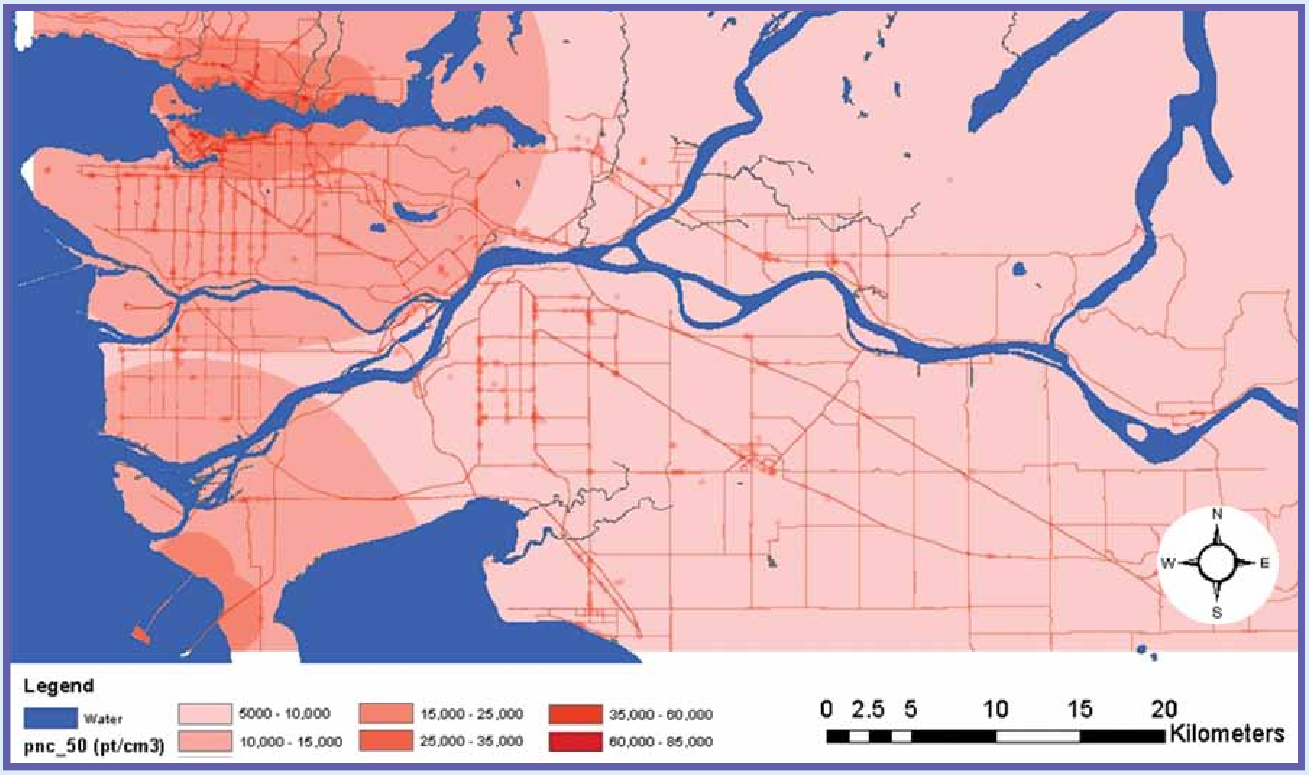


Fig. 5: Measurements showing that ultrafine particle counts are highest in close proximity to major roads. The measurements were used to develop a spatial model of ultrafine particle concentrations for the region.

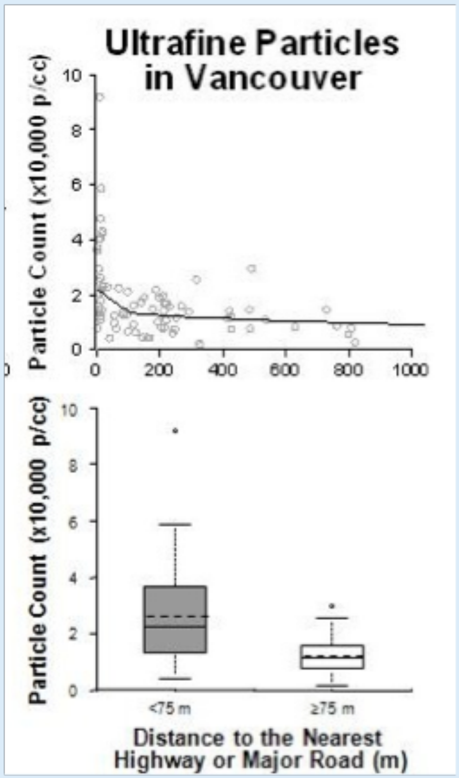


Fig. 6: Decreasing concentrations of ultrafine particles measured at various distances from a major road. From Albernethy R. A land use regression model for ultrafine particles in Vancouver, B.C. MSc Theses, UBC. 2011. https://circle.ubc.ca/handle/2429/41895

contributes to personal exposure to ambient UFP in urban areas. Depending on commuting mode, route type, and duration, exposures during commuting may account for as much as 50% of an individual's daily UFP exposure.

Toxicologic studies indicate that UFP are potentially toxic. While they do not appear to cause significant lung inflammation at environmentally-relevant concentrations, UFP can enhance allergen responses, affect the progression of atherosclerosis, and influence autonomic control of the heart.

There is also evidence that UFP have extra-pulmonary (neurologic, cardiovascular) effects. Experimental studies in humans further indicate that small proportions of inhaled UFP may cross into the epithelium and the bloodstream, but their significance from a clinical perspective is unclear.

Overall, the experimental toxicologic evidence demonstrates the potential for UFP to produce adverse health effects. However, no strong evidence exists to show a huge difference in effects between short-term exposures to UFP and to larger particles. The effects of long-term exposures have not been adequately investigated.

A large number of epidemiologic studies have similarly evaluated the effects of short-term exposures to UFP. These studies have inconsistent results, providing suggestive evidence only of human health effects at ambient concentrations due to UFP.

Like the experimental toxicologic studies, epidemiologic studies on long-term exposure effects of UFP are lacking. Presently, the available evidence does not provide strong support for regulations or management programs specifically targeting ambient concentrations of UFP.

Every year, the BC Lung Association's Air Quality and Health Steering Committee selects an individual, organization, community, physician or scientist who has made a difference in protecting air quality in our province and the lung health of its resi-

Prince George Air Improvement Roundtable

Prince George has a history of people working together to improve air quality. Industrial and non-industrial human activity, weather, and topography all pose a number of air quality challenges for Prince George. The Prince George Air Improvement Roundtable (PGAIR) is working to develop air quality solutions in support of its vision: Acceptable air quality is everyone's right. Protecting air quality is everyone's responsibility.

PGAIR is a multi-stakeholder, community-based, non-profit society composed of representatives from the general public, business, industry, community groups, government, academia, and the medical community. The group was originally formed in 1998 under a different name. In 2008, PGAIR became a non-profit society committed to researching, monitoring, recommending and implementing air quality improvements. The group also promotes public awareness and education in the Prince George airshed.

PGAIR strives to provide a place where air quality topics, issues, opportunities and implementation strategies can be explored from economic, environmental and social perspectives. PGAIR's integrated approach includes government, industry, the public, and local, regional, provincial and national jurisdictions. PGAIR Executive Director Terry Robert explains that "integrated collaborative processes like PGAIR help ensure the development and implementation of effective long-term strategies by identifying problems and solutions early."

Creating working groups to implement operational activities is a key component of PGAIR's approach. Through these working groups, various participating organizations are encouraged to work together toward advancing air quality improvements in three main areas: education and awareness; monitoring; and research.

> PGAIR Executive Director Terry Robert: "This is a critical time for us. We're in a position to implement recommendations made in our Phase 3 Airshed Management Plan."

"The range of agencies, jurisdictions and sectors represented through PGAIR and the working groups is impressive," notes Robert. "It is the relationships and systems that form through these processes that will help promote long-term air quality solutions for the community."

Preliminary data suggest the efforts of PGAIR, its predecessor, and the various stakeholder groups involved are paying off, with improvements in fine particulate matter and sulphur dioxide concentrations of 28% and 73% respectively since the mid 1990s, and in total reduced sulphur (associated with a rotten egg odour) of 84% since the late 1980s.

Despite these accomplishments, however, particulate matter concentrations in Prince George remain among the highest in B.C. A study conducted by Elliott and Copes in 2011 reveals that $PM_{2.5}$ concentrations accounted for up to 74 deaths per year in the Northern and Interior Health Areas. During the study period, Prince George had the highest annual average $PM_{2.5}$ of all the Northern BC and Interior communities monitored.

To help address air quality challenges, PGAIR welcomes the opportunity to collaborate with other communities. "There are a number of shared challenges that we can find collective solutions for," Robert believes. "For example, transportation-related emissions, both on- and off-roads, for which communities need to develop short- and long-term solutions that factor in economic, environmental and social considerations. We can make large gains addressing emission problems at provincial, regional and local scales."

"This is a critical time for PGAIR," Robert reflects. "After years identifying and researching air quality issues and building relationships in Prince George, PGAIR is currently in a position to implement recommendations made in our Phase 3 Airshed Management Plan: a five-year plan to develop strategies which can be utilized by all the stakeholders, whether or not they are PGAIR members. The plan aims to meet the emission reduction targets set by PGAIR by reducing particulate matter. It also seeks to create a community where social well-being is supported by a vibrant economy and sustained by a healthy environment."

For more information, visit http://PGAirQuality.com.

RADON:
threats, challenges & actions

A radon workshop was held on day 2 of the Air Quality and Health Workshop. The objective was to identify ways in which public health practitioners and others can work together to reduce radon levels in B.C. homes and buildings. The workshop was well attended by public health practitioners, dents. This year, the Committee recognizes the valuable contribution of two Clean Air Champions—the Prince George Air Quality Improvement Roundtable and Dana Schmidt, who founded the Donna Schmidt Memorial Lung Cancer Prevention Society in honour of his late wife.

Donna Schmidt Memorial Lung Cancer Prevention Society

In January 2009, Castlegar resident Dana Schmidt lost his wife Donna to lung cancer. “I spent a lot of time looking into cures, hoping I could save my wife,” he remembers. “Eventually, I had to acknowledge that this wasn’t going to happen, so I turned my attention to the causes of lung cancer.”

Radon exposure is responsible for over 200 lung cancer deaths in the province every year.

In his research, Schmidt discovered that exposure to radon gas is the second leading cause of lung cancer (smoking being the first). “I was a bit ignorant about radon, particularly its toxicity level,” he admits. “I had no idea just how deadly it was.”

Radon is an odourless, tasteless and invisible gas produced when naturally occurring uranium decays in water and soil. Most radon-induced lung cancers are due to long-term exposures in homes.

At his son’s insistence, Schmidt had his home tested for radon, only to discover that radon levels were 50% above Canada’s national guideline.

“I’ve done work on particulates in the air, carbon dioxide, nitrogen dioxide,” shares Schmidt, who has a PhD in Toxicology. “The hazard in my own home from radon gas was 500 times as deadly as that from other toxins!”

Health Canada’s guideline for yearly exposures is 200 ßq/m^3 (a measure of radioactive decays per second). Although no level of radon is safe, individuals can reduce their health risks by ensuring their homes are below this guideline.

Schmidt and his son Brian, a 2011 Nobel Prize winner in Physics, founded the Donna Schmidt Memorial Lung Cancer Prevention Society to help reduce lung cancer from home and workplace radon exposure.

> “Spending 70% of your time in your home greatly increases the risk of a very preventable cancer,” notes Dana Schmidt. “Do not smoke—and have your home tested for radon gas.”

The Society distributes radon test kits throughout the West Kootenays. Dana has also spoken to city councils and given many presentations to community groups on how to eliminate the hazards of radon gas.

One significant outcome of Dana’s work is that Castlegar’s City Council is now ready to adopt a new building code requiring new homes to be radon-resistant.

Dana advocates that government subsidies/grants be made available to mitigate radon levels in homes, like in Castlegar where 46% of homes tested were above the Canadian guideline.

In fact, according to the BC Centre for Disease Control, radon levels in Castlegar households are the second-highest recorded in the province. Schmidt is convinced that the savings to the health care system would far outweigh the cost of subsidies and upgrading homes.

“Exposure is cumulative,” Schmidt asserts. “Spending 70% of your time in your home greatly increases the risk of a very preventable cancer. Do not smoke—and have your home tested for radon gas.”

Schmidt recognizes that raising awareness of the issue is an ongoing campaign. He maintains that “if we can get even just 10% of the people to act, that will start saving lives. This is a real issue, not just a health scare. It’s supported by a number of studies.”

Schmidt`s goal is to prevent loss of life due to lung cancer by raising awareness of the importance of testing and mitigation and by advocating for changes in building codes and policy.

For more information, contact Dana Schmidt at (250) 365-0344, Ext. 227 or at dschmidt@golder.com. Or visit the society’s website at www.DDSchmidt.ShawWebSpace.ca.

scientists, physicians, policy makers, and students.

Workshop presenters covered a range of topics, including the health impacts of radon, how it moves from rock to homes and buildings, how it is distributed in B.C., testing and mitigation, as well as challenges in setting public policies on radon.

Several organizations and agencies described their radon programs, including Health Canada, Northern Health Authority, Interior Health Authority, the Donna Schmidt Memorial Lung Cancer Prevention Society, and the US Environmental Protection Agency, among others.

Radon releases tiny radioactive particles. When breathed in, they can damage the lining of the lung, which over a long period could result in lung cancer. Radon exposure is responsible for 200 lung cancer deaths in B.C. every year, and is the leading cause of lung cancer among non-smokers.

In smokers, exposure to both radon and cigarette smoke greatly increases the risk of lung cancer. Children are also vulnerable because—when they are exposed to radon’s damaging effects—they have a longer time to develop lung cancer over their lifetime compared to adults.

A key message from the workshop is that people should be aware of the health risk of radon and test their home, particularly those living in areas where radon levels are known to be high such as parts of the Interior and Northern B.C.

(Cont’d on p. 16)

TRENDS Air Pollution in B.C. through the Years

Fine Particulate Matter ($PM_{2.5}$)

Long-term $PM_{2.5}$ trends are available for a handful of monitoring sites in B.C. (see Figure 7). Concentrations in 2011 were the lowest of the past 14 years in Nanaimo, Kelowna and Prince George, and the second lowest over this period in Metro Vancouver. Local restrictions on open burning, emission reductions from light- and heavy-duty vehicles, and reduced emissions within Metro Vancouver from the petroleum refining and wood products sectors have contributed to these downward trends.

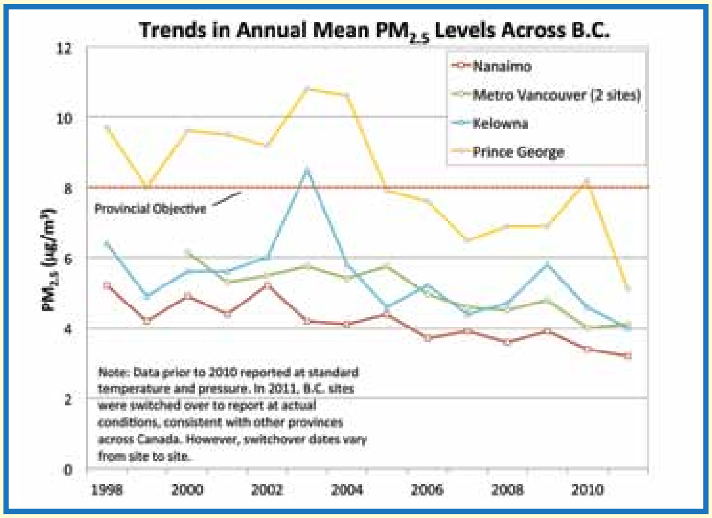


Fig. 7: Trends in annual $PM_{2.5}$ concentrations in µg/m^3 at selected sites from 1998 - 2011 (TEOM monitors only).

Nitrogen Dioxide (NO_2)

Figure 8 shows trends in annual mean NO_2 concentrations. Significant downward trends were observed in Metro Vancouver and the FVRD, reflecting reduced emissions due to improved vehicle emission standards and the AirCare vehicle inspection program. In Victoria and Kelowna, 2011 concentrations were the lowest of the past 10 years.

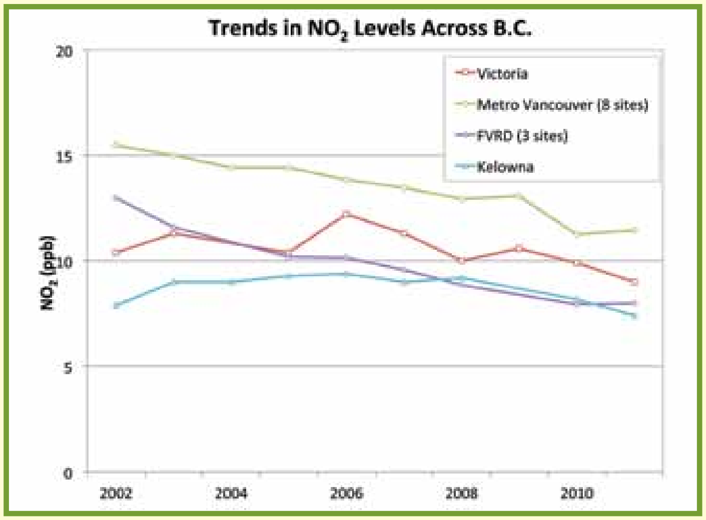


Fig. 8: Trends in annual mean NO_2 levels in ppb at selected sites from 2002 - 2011.

Ground-level Ozone (O_3)

No significant trends in O_3 were observed in B.C. based on the annual eight-hour daily maximum ozone values at 21 monitoring sites (see Figure 9). However, concentrations in 2011 were the lowest of the past 11 years in Victoria, Metro Vancouver and the FVRD, and the second lowest in Kelowna. These levels can be attributed partly to the cool, wet weather conditions in the first part of the summer of 2011.

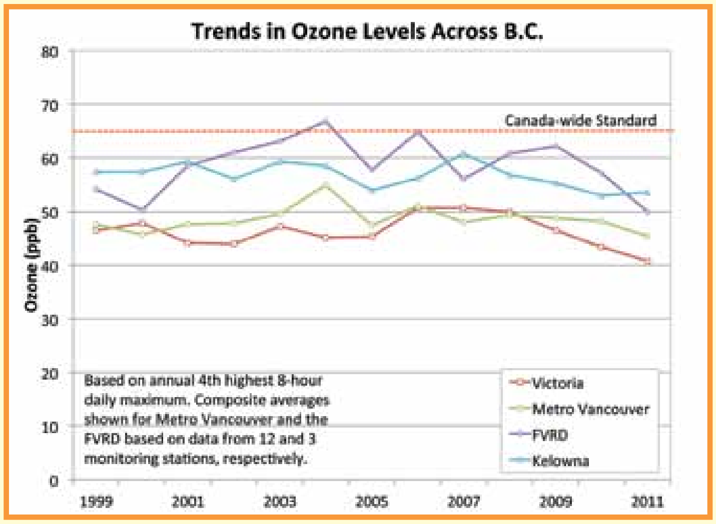


Fig. 9: Trends in O_3 concentrations in ppb based on the 4th highest daily eight-hour maximum concentrations at selected sites from 1999 - 2011.

Sulphur Dioxide (SO_2)

Figure 10 shows trends in annual SO_2 levels in Trail, Prince George, Metro Vancouver, and Chetwynd. Concentrations in Prince George and Metro Vancouver in 2011 were among the lowest recorded over the 11-year period. Concentrations at the Trail Butler Park site were the lowest in six years, while 2011 SO_2 levels in Chetwynd were the lowest since 2002.

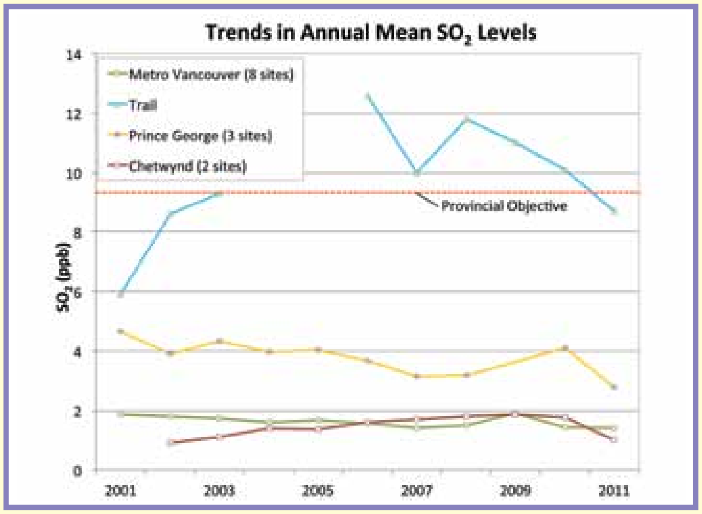


Fig. 10: Trends in annual mean SO_2 levels in ppb at selected B.C. sites from 2001 - 2011.

National Comparison

Air Quality levels at selected B.C. sites are compared with measurements from elsewhere in Canada. This does not reflect comprehensive ranking of Canadian cities as data from B.C. communities with the largest population or highest air pollution levels were compared against readily available measurements from other Canadian cities with a population greater than 150,000, where the types and sources may be quite different. Metro Vancouver, Abbotsford, Victoria and Kelowna are examples of such urban areas in B.C. However, this comparison does indicate how B.C. sites are doing relative to other parts of Canada.

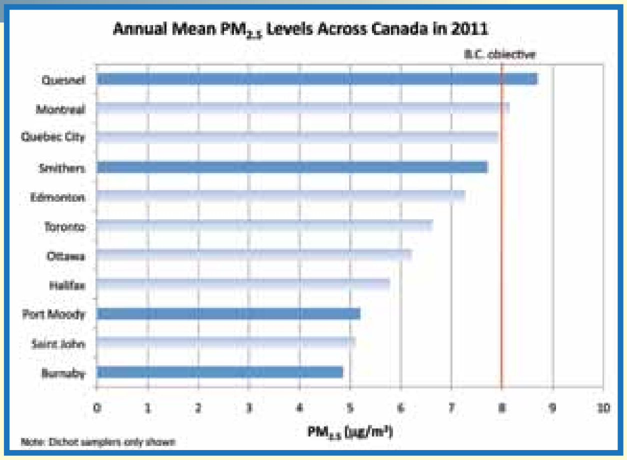


Fig. 11: Annual mean $PM_{2.5}$ concentrations in µg/m³ at selected Canadian cities in 2011 based on measurements from dichotomous samplers. B.C. sites are highlighted in dark blue.

Fine Particulate Matter ($PM_{2.5}$)

Figure 11 shows annual mean $PM_{2.5}$ concentrations. Of the selected sites, the highest concentrations in 2011 were recorded in Quesnel (8.7 µg/m³), followed by Montreal (8.2 µg/m³), Quebec City (7.9 µg/m³) and Smithers (7.7 µg/m³). In contrast, $PM_{2.5}$ concentrations at the Metro Vancouver sites were among the lowest of the sites examined.

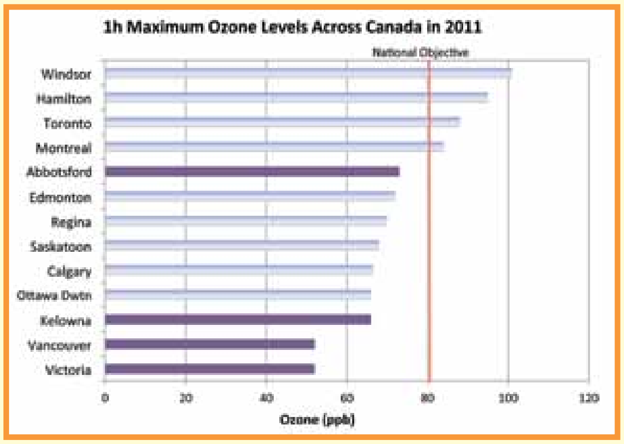


Fig. 12: Annual one-hour maximum O_3 concentrations in ppb in selected Canadian cities in 2011. B.C. sites are highlighted in dark purple.

Ozone (O_3)

Figure 12 shows maximum one-hour O_3 concentrations at various sites across Canada. The highest concentrations were found along the Windsor-Quebec corridor, particularly in Windsor (101 ppb), Hamilton (95 ppb), Toronto (88 ppb) and Montreal (84 ppb), each of which exceeded the national one-hour objective of 82 ppb. Concentrations measured at B.C. sites were comparatively low, with the highest one-hour concentration found in Abbotsford (73 ppb).

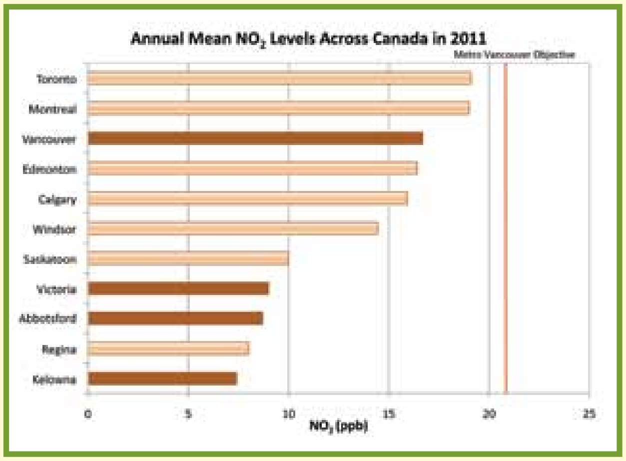


Fig. 13: Annual mean NO_2 concentrations in ppb in selected Canadian cities in 2011. B.C. monitoring sites are highlighted in brown.

Nitrogen Dioxide (NO_2)

Figure 13 shows annual mean NO_2 concentrations at various Canadian sites. Of the cities examined, the highest concentrations were observed in large urban areas, particularly Toronto and Montreal (both 19 ppb), followed by Vancouver (17 ppb). All sites were below national (31 ppb) and Metro Vancouver (21 ppb) objectives. Concentrations in Victoria, Abbotsford, and Kelowna were less than half the average NO_2 levels in Toronto and Montreal.

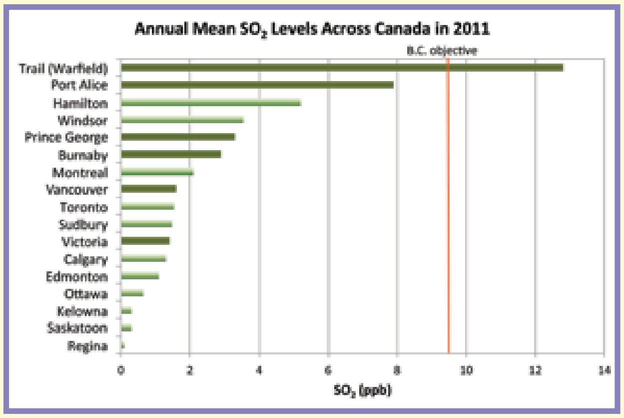


Fig. 14: Annual mean SO_2 concentrations in ppb in selected Canadian cities in 2011. B.C. monitoring sites are highlighted in dark green.

Sulphur Dioxide (SO_2)

Figure 14 shows annual mean SO_2 concentrations in selected Canadian cities. The highest levels were observed in the vicinity of Trail (12.8 ppb) and Port Alice (7.9 ppb), reflecting the proximity of these sites to major industrial sources. Only the Trail site exceeded the provincial objective. Concentrations in major cities elsewhere in Canada were at least a factor of two lower than the provincial objective, with the exception of Hamilton at 5.2 ppb.

FRASER VALLEY REGIONAL DISTRICT

Air Quality Monitoring Stations

In cooperation with Metro Vancouver, Fraser Valley Regional District (FVRD) will install two new air quality monitoring stations in Agassiz and Mission. Equipment has been provided in part through Environment Canada's National Air Pollution Surveillance (NAPS) Network, with assistance from the B.C. Ministry of Environment. The stations will become operational in mid-2012, and will be run and maintained cooperatively with Metro Vancouver.

Air Quality Management Plan

Work is continuing on an amendment to the FVRD Air Quality Management Plan. Once a new draft is completed, it will go through consultation and revision processes before being presented to the FVRD Board of Directors for adoption.

METRO VANCOUVER

Heavy-Duty Diesel Vehicle Remote Emission Testing Study

As part of its strategy to reduce emissions of and public exposure to diesel particulate matter, Metro Vancouver is considering options to reduce emissions from on-road, heavy-duty vehicles. Metro Vancouver—with the B.C. Ministry of Environment, FVRD, AirCare, Port Metro Vancouver and others—plans to collect real-life emission data representative of the local heavy-duty diesel fleet during a three-month trial period in the summer of 2012 using remote sensing device (RSD) technology. Through infrared and ultraviolet technology, RSD instantaneously reads emissions levels from vehicle stacks as they pass by.

New Bylaw for Non-Road Diesel Engines

In January 2012, a new bylaw for non-road diesel engines came into effect in Metro Vancouver. The bylaw will reduce emissions of diesel particulate matter (soot) from older, non-road diesel engines such as excavators, backhoes, and stationary equipment operating in the region. Non-road engines are a large source of air pollutants like diesel soot, which increases the risks for short- and long-term respiratory problems, heart and lung disease, and cancer.

Engine owners can reduce their fees or receive a refund by decreasing emissions or retiring an engine. There are also staged prohibitions against operating Tier 0 and Tier 1 engines starting in 2015 and 2020, respectively.

Reducing Exposure to Traffic Emissions

In partnership with the B.C. Ministry of Environment and TransLink, and with input from several municipalities, health authorities and other government agencies, Metro Vancouver initiated a consulting study to evaluate strategies to reduce resident exposure to traffic-related air pollutants, and to develop air quality-focused land use planning and urban design guidelines.

Controlling Open Burning Emissions and Odour

Metro Vancouver plans to propose an Open Burning Smoke Control Regulation to manage the discharge of air pollutants from smoke caused by the uncontrolled burning of vegetative materials such as land clearing debris and backyard waste. To meet the goals of regional liquid and solid waste management plans, Metro Vancouver is likewise addressing malodorous substance emissions from select sources in the region, including new facilities. Regulatory requirements would be proposed for odours from industrial operations, such as composting, aerobic and anaerobic digestion, and rendering facilities. Consultation with industry, government, and the public about these two initiatives is expected to take place throughout 2012.

Caring for the Air

Metro Vancouver's first annual Caring for the Air report, which describes air quality and climate change issues in the Lower Mainland, was prepared to complement the BC Lung Association's State of the Air Report. It is available at www.MetroVancouver.org/Services/Air/Documents/Caring_for_Air-MV2012.pdf.

B.C. MINISTRY OF ENVIRONMENT

The Ministry of Environment seeks to protect the environment and prevent pollution through monitoring, reporting, regulations and enforcement activities. Among the Ministry's most recent programs are the following:

Smoke Management

The Open Burning Smoke Control Regulation outlines the conditions under which open burning of vegetative debris can be authorized. These conditions include setback distances from residences, schools, hospitals and care facilities; favourable venting conditions; smoke release periods; and number of burns per year. Proposed changes to this regulation were discussed in Intentions Papers released to the public in 2010 and 2011. This regulation is expected to be finalized by the end of 2012.

The Solid Fuel Burning Domestic Appliance Regulation sets out the requirements for selling wood stoves and other solid fuel-burning domestic appliances. This regulation is being updated to include a wider range of wood-burning appliances, such as outdoor wood-fired boilers, and to adopt more stringent emission standards for fine particulate matter. Proposed changes to the regulation were described in a 2010 Intentions Paper that can be found at: www.Env.Gov.BC.ca/Epd/Codes/Solid-Fuel/Index.htm.

The Wood Residue Burner and Incinerator Regulation was amended in 2011. The amendment requires phas-





ing out all remaining beehive burners in B.C. by December 31, 2016. The parts of the regulation dealing with emissions from incinerators were also removed. These changes will encourage lower environmental impact end-uses for wood residuals.

Air Quality Monitoring

The Ministry (like Metro Vancouver and the FVRD) is in the process of upgrading its network of continuous $PM_{2.5}$ monitors from the current TEOM instrument to models providing a more complete measurement of $PM_{2.5}$ mass. Widespread reporting of data from the new instruments is expected to commence in 2013.

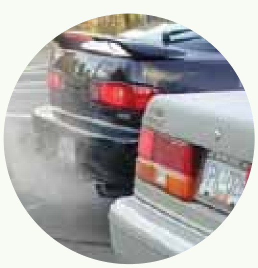
Smoke Forecasting Tool

The Western Canada BlueSky Smoke Forecasting System was launched in 2010 as a tool to provide up-to-date wildfire smoke forecasts based on satellite technology, forest inventory data, and weather forecasts. It is the product of a multi-agency collaboration, which includes the provinces of B.C., Alberta and Manitoba, federal agencies, the University of British Columbia, and the U.S. Forest Service. Twice-daily forecasts (in the morning and afternoon) are now available at: www.BCAirQuality.ca/BlueSky.

Other Activities

Over the past year, the B.C. Environment Ministry published a guideline for municipal solid waste combustion. The document provides policy guidelines for the issuance of air discharge authorizations—including numerical emission limits for new and existing facilities—and expectations for monitoring and best management plans. The document better prepares Ministry decision-makers in dealing with possible new facilities in the province.

The Ministry has also published four new Fact Sheets on Biomass-Fired Electrical Power Generation, Wood Pellet Manufacturing Facilities, Combustion of Municipal Solid Waste, and Best Available Technology. These publications summarize key emissions information contained in the Ministry's Guidelines governing these four activities.



Finally, the Ministry has updated its inventory of local government bylaws on open burning, wood heating and anti-idling. The report is expected to be useful to communities who are considering adopting or updating air quality bylaws and to the concerned public. The report can be found at: www.BCAirQuality.ca/Reports/pdfs/Bylaws-2011.pdf.

HEALTH CANADA

Air Quality Health Index

Health Canada will study how to address two key elements of its AQHI research plan: one, the AQHI's accuracy in predicting health risk in rural areas and smaller cities and towns; two, the AQHI's effectiveness in reducing health risk among vulnerable populations.

B.C.'s rural areas have a distinct mix of pollutants compared to urban areas where the majority of air pollution research has been done. The first part of the study will measure health markers in a sample of individuals living in a rural area and evaluate their relationship with the AQHI. The second part will examine the use of mobile technology in sending updated AQHI health messages directly to cellphones of people vulnerable to air pollution's health effects.

The Environmental Health Program at Health Canada continues to participate in promotional and awareness activities related to the AQHI. The AQHI is currently available in 21 locations in B.C., representing over 1/3 of AQHI communities in Canada, and continues to be implemented in communities across the country. For current and forecasted AQHI in your region, visit: www.BCAirQuality.ca. For more information on the AQHI, go to: www.AirHealth.ca.

Transit

Health Canada will study the levels of pollutants that Metro Vancouver's bus and light rail transit commuters are exposed to along their routes.

Indoor Air Quality

The Environmental Health Program continues to participate in provincial programs raising awareness of radon's health risks, in addition to encouraging the testing and remediation of homes to reduce radon levels. Health Canada is also collaborating with the BC CDC and SFU Health Sciences on two research studies: one, on developing a framework for carbon monoxide in long-term care facilities and hospitals; the other, on phthalates exposure in children.

COLLABORATIVE INITIATIVES

Visual Air Quality

A pilot project is underway to develop a visual air quality management pro-

(Cont'd on p. 16)

Fig. 15: Various instruments monitor visual air quality in Metro Vancouver and the Lower Fraser Valley. The camera on the left is programmed to take photos every 30 minutes for uploading to the Clear Air BC website. Nephelometers in the centre photo measure light scattering by particles and gases every hour. Scattering and light absorption measurements are combined to arrive at a near real-time measurement of visibility conditions. The speciated particulate matter (PM) sampler on the right collects fine particulate matter onto a filter over a 24-hr. period. Lab analysis helps determine which pollutants affect visibility degradation.

(**Partner Agencies**... cont'd from p. 15)

gram for Metro Vancouver and the Lower Fraser Valley. Monitoring and computer modelling of visual air quality have been enhanced over the past year, and much more is planned. Steps have also been taken to improve how visual air quality is communicated to the public. This includes posting hourly images of six scenic vistas from Lions Bay to Burnaby to Chilliwack on the Clear Air BC website (www.ClearAirBC.ca). These images will help identify when and where visual air quality is diminished. In the near future, these photos will be accompanied by a new Visual Air Quality Rating linking pollution concentration to air clarity. (See Figure 15 for related information.)

Wood Stove Exchange Program

The Provincial Wood Stove Exchange Program provides financial incentives for upgrading old wood stoves, in addition to educating wood burners on how to improve their burning practices. In December 2011, the province announced $200,000 new funding to support the change-out programs in 12 communities. By the end of 2012, over 5,000 old stoves are expected to have been exchanged for cleaner burning models. This includes 106 exchanges in the FVRD and 225 exchanges in Metro Vancouver. This equates to a reduction of over 310 tonnes of $PM_{2.5}$ per year.

(**Radon**... cont'd from p. 11)

Testing is easy, inexpensive and can be done with a "do-it-yourself" test kit. Contact the BC Lung Association (www.BC.Lung.ca/AirQuality/Air-Quality_Radon_qanda.html) or the Northern Health Authority (www.NorthernHealth.ca/YourHealth/EnvironmentalHealth/Radon.aspx) to purchase a $30 test kit. If you live in the Castlegar area, contact the Donna Schmidt Memorial Lung Cancer Prevention Society for a test kit (see contact information on page 11).

To view presentations from this workshop, please visit: www.BC.Lung.ca/Association_and_Services/Air_Quality_Workshop.html.

Visit or contact the following agencies FOR MORE INFORMATION

BC LUNG ASSOCIATION
www.bc.lung.ca
2675 Oak Street
Vancouver, B.C. V6H 2K2
(604) 731-5864 or toll-free at 1-800-665-5864 (in B.C. but outside the Lower Mainland)

ENVIRONMENT CANADA - PACIFIC AND YUKON REGION
www.pyr.ec.gc.ca
401 Burrard Street
Vancouver, B.C. V6C 3S5
(604) 664-9100

HEALTH CANADA ENVIRONMENTAL HEALTH PROGRAM - B.C. REGION
www.hc-sc.gc.ca/ewh-semt/air/index-eng.php
400-4595 Canada Way
Burnaby, B.C. V5G 1J9
(604) 666-2671

BC CENTRE FOR DISEASE CONTROL
www.bccdc.ca
655 West 12th Avenue
Vancouver, B.C. V5Z 4R4
(604) 707-2400

B.C. MINISTRY OF ENVIRONMENT
www.bcairquality.ca

Environmental Standards Branch
PO Box 9341, Stn Prov Govt
Victoria, B.C. V8W 9M1
(250) 387-9932

Ministry of Environment Regional Offices
www.env.gov.bc.ca/main/regions.html

METRO VANCOUVER
www.metrovancouver.org
4330 Kingsway
Burnaby, B.C. V5H 4G8
(604) 432-6200

FRASER VALLEY REGIONAL DISTRICT
www.fvrd.bc.ca
45950 Cheam Avenue
Chilliwack, B.C. V2P 1N6
(604) 702-5000 or 1-800-528-0061

B.C. MINISTRY OF HEALTH
www.bcairquality.ca

Health Protection Branch
1515 Blanshard Street, RBB 4-2
Victoria, B.C. V8W 3C8
(250) 952-1469

BRITISH COLUMBIA HEALTH AUTHORITIES

Northern Health Authority
www.northernhealth.ca
Suite 600, 299 Victoria Street
Prince George, BC V2L 5B8
(250) 565-2649

Vancouver Island Health Authority
www.viha.ca
1952 Bay Street
Victoria, B.C. V8R 1J8
(250) 370-8699

Vancouver Coastal Health Authority
www.vch.ca
11th Floor, 601 West Broadway
Vancouver, B.C. V5Z 4C2
(604) 736-2033 or 1-866-884-0888

Fraser Health Authority
www.fraserhealth.ca
Suite 400, Central City Tower
13450–102nd Avenue
Surrey, B.C. V3T 0H1
(604) 587-4600 or 1-877-935-5669

Interior Health Authority
www.interiorhealth.ca
220-1815 Kirschener Rd
Kelowna, B.C. V1Y 4N7
(250) 862-4200

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2012 State of the Air Report

Technical Appendix

Table A-1 Summary of $PM_{2.5}$ concentrations at B.C. TEOM sites in 2011. All concentrations in $\mu g/m^3$.

Station ID	Location	No. Valid Days	No. Valid Hours	Mean	Min	Percentiles (1-hour) 25	50	75	98	99	Maximum 1-hour	24-hour	>25 $\mu g/m^3$ No.	%	>30 $\mu g/m^3$ No.	%	CWS
E223615	Kitimat Whitesail	352	8466	1.5	0	1	1	2	5	6	52	8	0	0.0	0	0.0	.
E282711	Kitimat Haisla Village	330	7941	1.9	0	1	2	2	6	6	77	24	0	0.0	0	0.0	.
E216670	Kitimat Riverlodge	364	8681	2.3	0	1	2	3	7	7	35	8	0	0.0	0	0.0	8
M107028	Terrace	361	8576	2.7	0	1	2	3	8	11	42	13	0	0.0	0	0.0	9
E223616	Kitimat Haul Rd	352	8413	3.1	0	2	3	4	8	9	50	10	0	0.0	0	0.0	.
E229797	Nanaimo	361	8667	3.2	0	2	3	4	8	8	30	10	0	0.0	0	0.0	9
E227431	Whistler	352	8399	3.3	0	2	3	4	9	11	43	14	0	0.0	0	0.0	13
E273443	Crofton Escarpment	316	7602	3.4	0	2	3	5	8	9	43	12	0	0.0	0	0.0	10
E283549	Tsawwassen	363	8707	3.5	0	2	3	5	8	9	31	11	0	0.0	0	0.0	.
E222520	Campbell River	360	8615	3.5	0	2	3	4	10	12	57	15	0	0.0	0	0.0	11
E275843	Horseshoe Bay	362	8697	3.6	0	2	3	5	8	9	30	11	0	0.0	0	0.0	10
0310177	Burnaby Kensington Park	362	8689	3.6	0	2	3	5	9	10	44	10	0	0.0	0	0.0	12
E207418	Burnaby South	364	8695	3.8	0	2	4	5	9	10	59	11	0	0.0	0	0.0	11
E238212	Abbotsford Mill Rd.	364	8702	3.8	0	2	3	5	10	11	39	15	0	0.0	0	0.0	.
E258315	Nelson	365	8708	3.8	1	2	3	5	10	12	43	16	0	0.0	0	0.0	10
E232244	Pitt Meadows	356	8540	4.0	0	2	4	5	10	11	150	12	0	0.0	0	0.0	12
0500886	Kelowna	365	8711	4.0	0	2	3	5	12	14	102	23	0	0.0	0	0.0	17
0450270	Prince George Gladstone	364	8668	4.1	0	2	3	5	15	20	44	23	0	0.0	0	0.0	22
E206271	Surrey East	363	8684	4.2	0	2	4	6	9	10	26	14	0	0.0	0	0.0	.
E220891	Chilliwack	355	8488	4.2	0	2	4	5	10	14	30	15	0	0.0	0	0.0	11
E232246	Richmond Airport	365	8711	4.2	1	2	4	6	11	11	102	13	0	0.0	0	0.0	12
E221199	Creston	365	8716	4.2	0	2	4	6	12	14	36	20	0	0.0	0	0.0	12
0310175	Vancouver Kitsilano	357	8564	4.3	0	3	4	6	9	10	53	12	0	0.0	0	0.0	11
E248797	Williams Lake CRD Library	365	8673	4.3	0	2	4	6	12	14	50	22	0	0.0	0	0.0	15

Table A-1. Continued.

Station ID	Location	No. Valid Days	No. Valid Hours	Mean	Min	Percentiles (1-hour) 25	50	75	98	99	Maximum 1-hour	24-hour	>25 μg/m³ No.	%	>30 μg/m³ No.	%	CWS
E225267	Burns Lake	344	8261	4.3	0	2	4	6	14	15	63	23	0	0.0	0	0.0	14
E207417	Richmond South	364	8695	4.4	0	3	4	6	11	12	45	16	0	0.0	0	0.0	.
E209178	Langley	362	8687	4.4	0	2	4	6	13	16	62	19	0	0.0	0	0.0	14
0310179	N. Vancouver Second Narrows	353	8449	4.5	1	3	4	6	10	10	27	11	0	0.0	0	0.0	13
0310162	Port Moody	362	8660	4.5	0	3	4	6	10	12	42	14	0	0.0	0	0.0	.
0550502	Williams Lake Columneetza	362	8656	4.5	0	2	4	6	14	17	50	21	0	0.0	0	0.0	64
E230557	Telkwa	363	8652	4.6	0	2	3	6	16	18	66	20	0	0.0	0	0.0	16
E283369	Prince George Exploration Pl.	365	8670	4.6	0	2	4	6	17	21	66	24	0	0.0	0	0.0	.
M107004	Hourston	362	8636	4.7	0	2	4	6	18	20	70	23	0	0.0	0	0.0	20
E248021	Revelstoke	365	8691	4.8	1	3	4	6	12	13	42	17	0	0.0	0	0.0	21
E249492	Vernon	361	8680	4.9	0	3	4	6	13	14	35	20	0	0.0	0	0.0	17
E206589	Smithers	354	8455	5.1	1	2	4	7	17	18	56	30	0	0.3	0	0.0	18
0450307	Prince George Plaza 400	355	8541	5.1	0	2	4	7	18	22	82	26	1	0.3	0	0.0	26
E283370	Prince George Denicola Ranch	364	8665	5.4	0	4	5	6	14	16	56	22	0	0.0	0	0.0	.
E263701	Grand Forks	356	8509	5.8	1	3	5	7	18	20	70	32	2	0.6	1	0.3	18
E235070	Golden	365	8700	6	1	3	5	9	15	16	57	19	0	0.0	0	0.0	18
E216667	Quesnel Maple Dr.	361	8601	6.3	0	3	5	9	21	27	80	32	4	1.1	2	0.6	33
E208096	Quesnel Sr. Sec.	333	8067	6.5	0	4	5	9	18	20	71	26	1	0.3	0	0.0	29

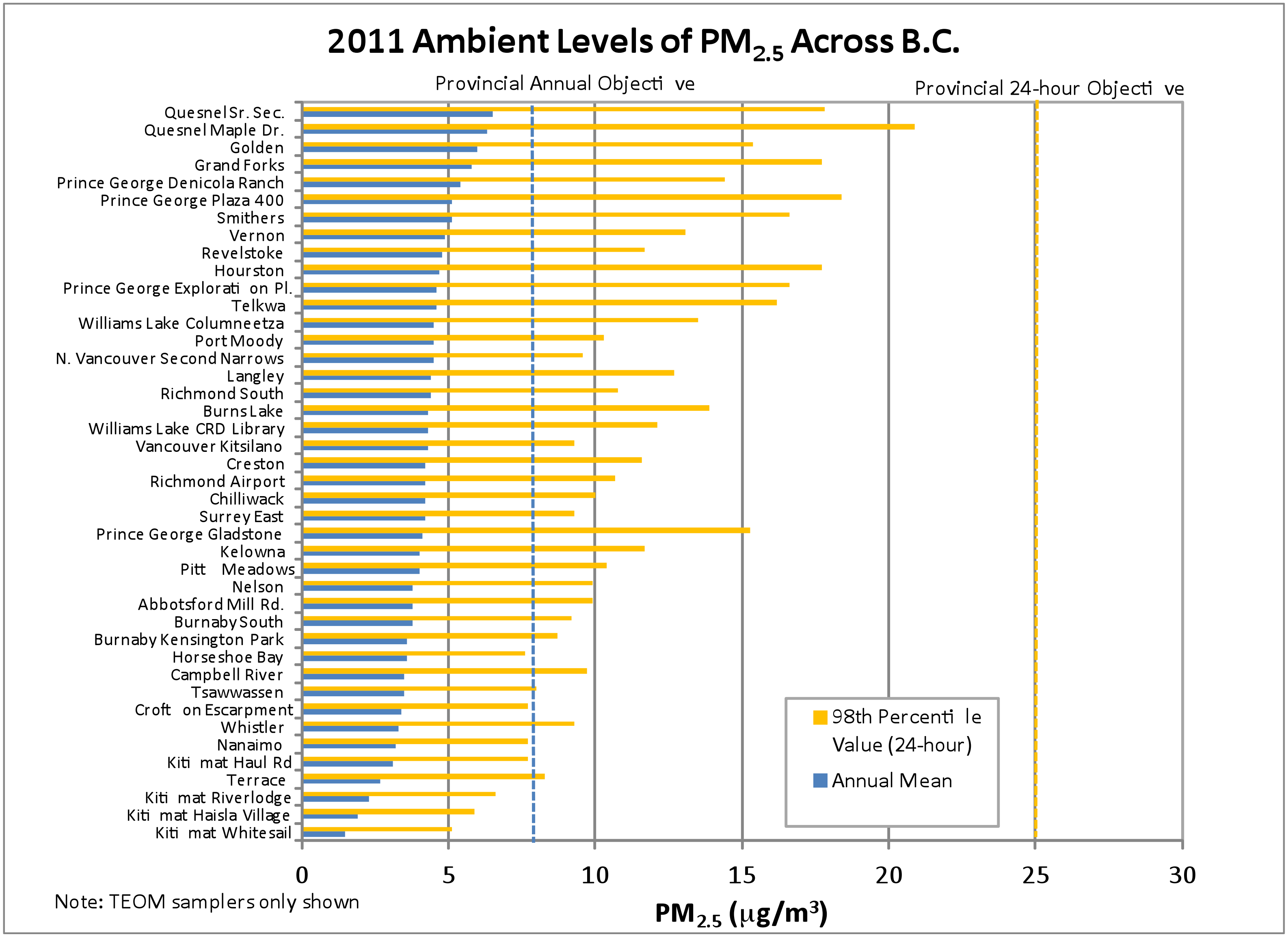

Figure A-1. Annual mean (blue bar) and 98th percentile (yellow bar) concentrations of $PM_{2.5}$ at B.C. TEOM sites in 2011.

Table A-2. Summary of ozone concentrations at B.C. sites in 2011. All concentrations in ppb.

		No.	No.			Percentiles (1-hour)						Hours >82 ppb		Daily 8-hour Maximum	
Station	**City**	**Valid Days**	**Valid Hours**	**Mean**	**Min.**	**25**	**50**	**75**	**98**	**99**	**Max.**	**No.**	**%**	**Annual 4th Highest**	**CWS (2009-2011)**
0310179	N. Vancouver Second Narrows	363	8592	14.9	0	6	13	22	38	40	48	0	0	40	41
0310177	Burnaby Kensington	356	8428	16.3	0	7	15	25	39	41	47	0	0	42	44
E207418	Burnaby South	365	8590	17.2	0	7	17	26	39	41	46	0	0	41	44
E232246	Richmond Airport	363	8582	17.1	0	5	17	27	41	42	49	0	0	42	44
E231866	Victoria	349	8101	16.3	0	7	16	24	37	39	52	0	0	41	44
E207723	North Delta	365	8617	17.6	0	7	17	27	42	43	54	0	0	45	45
E209177	N. Vancouver Mahon Park	365	8606	17.4	0	8	17	26	41	43	53	0	0	45	45
E222520	Campbell River	365	8396	21	1	13	21	29	40	42	49	0	0	44	46
E277329	Duncan	364	8345	17.9	0	5	17	28	43	45	56	0	0	47	47
E229797	Nanaimo	362	8358	22.1	0	14	22	30	42	44	53	0	0	46	47
E207417	Richmond South	365	8594	17.2	0	3	16	29	43	44	51	0	0	45	47
0310175	Vancouver Kitsilano	358	8487	15	0	3	13	25	42	44	52	0	0	45	47
0310162	Port Moody	360	8562	14.3	0	2	12	24	42	44	50	0	0	44	48
E206270	Burnaby Mountain	364	8612	26.6	0	20	27	34	45	46	55	0	0	48	49
E242892	Coquitlam	365	8611	16.7	0	6	15	27	43	45	55	0	0	45	49
E232244	Pitt Meadow	361	8510	18.9	0	7	19	30	44	47	58	0	0	48	49
0310172	Squamish	353	8132	17	0	6	16	26	41	43	50	0	0	45	49
E283549	Princr George Gladstone School	363	8594	22.8	0	13	23	32	45	46	52	0	0	48	49
E258315	Nelson	363	8383	25	2	17	24	32	47	49	60	0	0	52	50
E206589	Smithers	359	8270	18.9	0	6	18	29	46	48	67	0	0	50	50
E206271	Surrey East	361	8611	20.2	0	10	20	30	44	45	58	0	0	49	50
E249492	Vernon	362	8326	19.7	0	7	18	31	47	49	59	0	0	51	51
E209178	Langley	364	8608	20.6	0	9	21	31	44	46	61	0	0	48	52
E208096	Quesnel Sr. Secondary	330	7910	18.4	0	5	16	28	48	50	65	0	0	52	52
E227431	Whistler	363	8340	21.9	0	11	21	32	48	50	64	0	0	51	53
0550502	Williams Lake Columneetza	353	8194	21.5	0	10	22	31	48	50	63	0	0	53	53
0500886	Kelowna	365	8353	25.6	0	16	26	35	50	52	66	0	0	54	54

Table A-2. Continued.

		No.	No.			Percentiles (1-hour)						Hours >82 ppb		Daily 8-hour Maximum	
Station	City	Valid Days	Valid Hours	Mean	Min.	25	50	75	98	99	Max.	No.	%	Annual 4th Highest	CWS (2009-2011)
E257415	Osoyoos	340	8076	30.1	3	22	30	37	50	52	60	0	0	54	54
E238212	Abbotsford Mill Rd.	357	8449	19	0	7	18	30	44	47	73	0	0	50	55
E232245	Maple Ridge	363	8586	19.6	0	8	19	30	44	47	62	0	0	50	55
E220891	Chilliwack	364	8588	17.7	0	5	17	28	44	47	69	0	0	50	56
E223756	Hope	362	8560	17.9	0	5	17	28	45	48	59	0	0	50	58
E240337	Colwood	337	7772	22.7	0	12	24	33	45	47	53	0	0	48	.

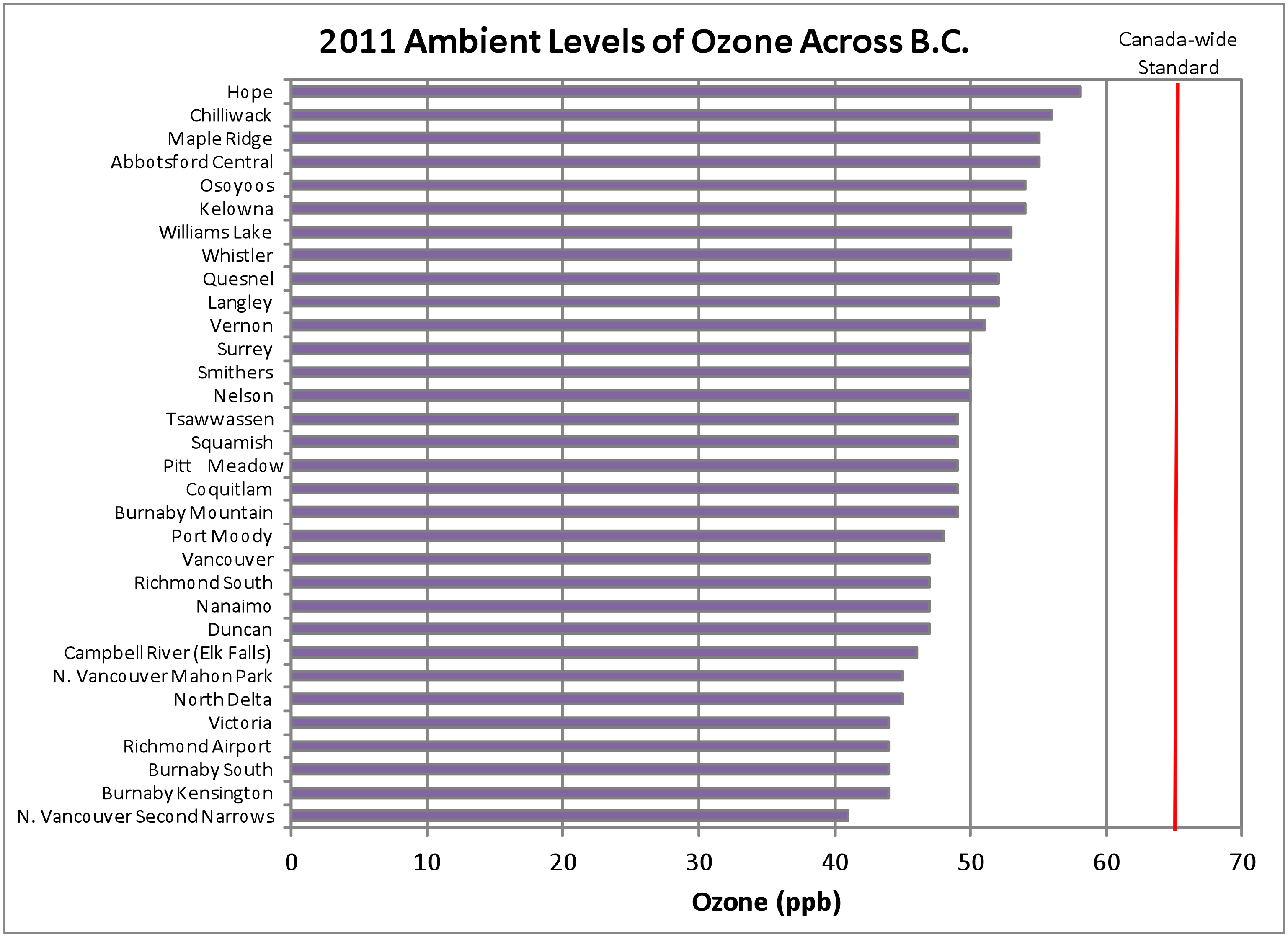

Figure A-2. Annual ozone concentrations at B.C. sites in 2011. Based on annual 4th highest daily 8-hour maxima, averaged over three years (2009-2011).

Table A-3. Summary of annual NO_2 concentrations at B.C. sites in 2011. All concentrations in $\mu g/m^3$.

Station ID	Location	No. Valid Days	No. Valid Hours	Mean	Min	Percentiles (1-hour) 25	50	75	98	99	Max	>209 ppb No.	%
0310177	Burnaby Kensington Park	358	8549	11.2	1	7	10	15	28	31	41	0	0
E206270	Burnaby Mountain	363	8608	8.1	0	4	7	10	24	28	44	0	0
E207418	Burnaby South	346	8197	14	2	8	13	19	33	35	46	0	0
E222520	Campbell River	364	8389	5.3	0	3	4	7	17	20	40	0	0
E220891	Chilliwack	357	8452	8.1	0	4	7	11	22	24	39	0	0
E242892	Coquitlam	364	8605	10.7	1	6	9	14	27	29	43	0	0
E277329	Duncan	364	8341	5.2	0	2	4	7	16	18	30	0	0
E223756	Hope	355	8391	7.2	0	3	6	10	20	22	38	0	0
0500886	Kelowna	365	8351	7.4	0	3	5	10	26	29	39	0	0
E222778	Langdale	354	8176	5.1	0	3	4	7	14	16	29	0	0
E209178	Langley	362	8597	6.3	0	3	5	9	19	21	29	0	0
E232245	Maple Ridge	364	8614	7.6	1	4	6	10	22	25	37	0	0
E209177	N. Vancouver Mahon Park	363	8601	11.4	1	6	10	15	28	31	40	0	0
0310179	N. Vancouver Second Narrows	354	8437	13.3	1	8	12	17	32	36	65	0	0
E229797	Nanaimo	362	8360	7.4	0	3	6	10	21	23	31	0	0
E207723	North Delta	365	8617	13.3	1	7	11	19	34	36	47	0	0
E257415	Osoyoos	350	8300	2.7	0	1	2	3	10	13	36	0	0
E232244	Pitt Meadows	358	8511	7.2	0	3	6	10	23	26	41	0	0
0310162	Port Moody	358	8564	12.6	0	8	12	17	28	31	43	0	0
0220204	Powell River	365	8390	2.2	0	1	2	3	8	9	20	0	0
E238212	Princr George Gladstone	335	8090	8.7	0	4	7	12	24	26	36	0	0
E208096	Quesnel Sr. Secondary	334	7908	9.8	0	4	7	13	34	38	47	0	0
E232246	Richmond Airport	364	8599	14.3	1	6	13	21	35	36	48	0	0
E207417	Richmond South	365	8599	13.1	1	6	11	20	32	34	47	0	0
0310172	Squamish	358	8281	6.7	0	4	6	9	17	20	30	0	0
E206271	Surrey	361	8607	9.6	1	5	8	13	27	30	43	0	0
E283549	Tsawwassen	362	8585	7	0	3	5	10	24	27	63	0	0
E282169	Ucluelet	327	7824	0.9	0	0	1	1	4	5	17	0	0
0310175	Vancouver Kitsilano	360	8512	16.7	1	9	16	24	36	38	49	0	0
E249492	Vernon	353	8138	10.2	0	4	8	15	29	32	49	0	0
E231866	Victoria	344	8008	9	0	5	8	12	25	28	44	0	0

Table A-3. Continued.

Station ID	Location	No. Valid Days	No. Valid Hours	Mean	Min	Percentiles (1-hour) 25	50	75	98	99	Max	>209 ppb No.	%
E227431	Whistler	360	8197	5.1	0	2	4	7	18	21	28	0	0
0550502	Williams Lake Columneetza	350	8067	9.7	1	4	8	14	30	33	44	0	0

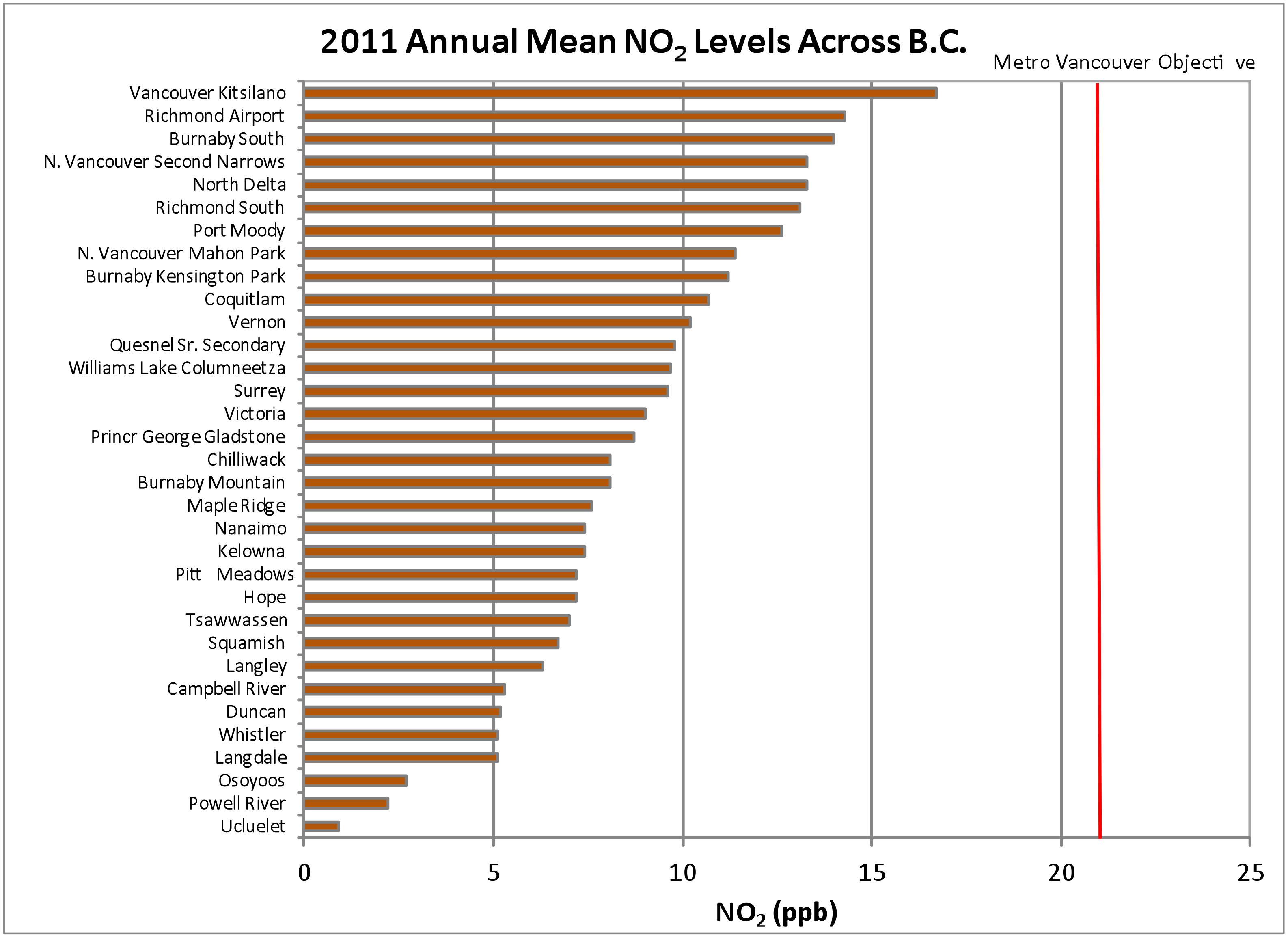

Figure A-3. Annual mean NO_2 concentrations across B.C. in 2011.

Table A-4. Summary of annual SO_2 concentrations at B.C. sites in 2011. All concentrations in $\mu g/m^3$.

Station ID	Location	No. Valid Days	No. Valid Hours	Mean	Min	Percentiles (1-hour) 25	50	75	90	98	99	Max	>170 ppb No.	>170 ppb %	>340 ppb No	>340 ppb %
E220891	Chilliwack	364	8582	0.1	0	0	0	0	0	1	1	5	0	0	0	0
E238212	Abbotsford Mill Rd.	351	8327	0.3	0	0	0	0	1	1	2	8	0	0	0	0
0500886	Kelowna	362	8328	0.3	0	0	0	1	1	1	1	3	0	0	0	0
E282711	Kitimat Haisla Village	364	8331	0.3	0	0	0	0	1	1	2	27	0	0	0	0
E209178	Langley	363	8605	0.3	0	0	0	0	1	1	2	6	0	0	0	0
E232244	Pitt Meadows	361	8522	0.4	0	0	0	1	1	2	2	6	0	0	0	0
E208096	Quesnel Sr. Secondary	327	7840	0.5	0	0	0	1	1	4	6	25	0	0	0	0
E234230	Taylor South Hill	355	8250	0.5	0	0	0	1	1	4	6	34	0	0	0	0
E249492	Vernon	362	8326	0.5	0	0	0	1	1	2	2	4	0	0	0	0
E237631	Pine River Hasler	340	7928	0.6	0	0	1	1	1	2	2	29	0	0	0	0
E207417	Richmond South	365	8592	0.6	0	0	0	1	1	2	3	12	0	0	0	0
E283549	Tsawwassen	363	8591	0.6	0	0	0	1	1	3	4	15	0	0	0	0
E207418	Burnaby South	365	8600	0.7	0	0	0	1	2	3	4	12	0	0	0	0
E270963	Prince George Marsulex	365	8360	0.7	0	0	0	1	1	4	6	19	0	0	0	0
0605008	Kamloops Federal Bldg	331	7749	0.8	0	0	1	1	2	4	5	28	0	0	0	0
E232246	Richmond Airport	354	8357	0.8	0	0	1	1	2	3	4	10	0	0	0	0
E229797	Nanaimo Labieux	355	8206	0.9	0	1	1	1	2	3	4	11	0	0	0	0
0310172	Squamish	364	8351	0.9	0	1	1	1	2	3	4	10	0	0	0	0
E222778	Langdale	330	7671	1	0	1	1	1	2	3	4	10	0	0	0	0
0310177	Burnaby Kensington Park	353	8411	1.2	0	0	1	1	3	7	9	65	0	0	0	0
0310162	Port Moody	361	8572	1.2	0	0	1	1	3	7	9	24	0	0	0	0
0450270	Prince George Gladstone	364	8329	1.2	0	0	0	1	3	10	16	46	0	0	0	0
E220217	Crofton Substation	365	8386	1.3	0	1	1	2	2	6	9	38	0	0	0	0
E223616	Kitimat Haul Road	364	8354	1.3	0	0	1	1	3	10	13	63	0	0	0	0
E209177	N. Vancouver Mahon Park	365	8590	1.4	0	0	1	2	3	7	10	31	0	0	0	0
E231866	Victoria	347	8075	1.4	0	1	1	2	2	5	6	25	0	0	0	0
0770708	Taylor Townsite	363	8378	1.5	0	0	0	1	3	16	23	100	0	0	0	0
0310175	Vancouver Kitsilano	360	8515	1.6	0	0	1	2	4	7	9	20	0	0	0	0
E244516	Burnaby Capitol Hill	358	8509	1.7	0	0	1	2	4	11	14	74	0	0	0	0
0450307	Prince George Plaza 400	342	8099	1.8	0	0	1	2	4	14	20	53	0	0	0	0
0310179	N. Vancouver Second Narrows	363	8596	2	0	0	1	2	6	14	18	48	0	0	0	0

Table A-4. Continued.

		No.	No.			Percentiles (1-hour)							>170 ppb		>340 ppb	
Station ID	Location	Valid Days	Valid Hours	Mean	Min	25	50	75	90	98	99	Max	No.	%	No	%
E244517	Burnaby North	365	8611	2.9	0	1	2	4	7	14	20	77	0	0	0	0
E209179	Prince George CBC Transmitter	364	8347	3.2	0	0	1	2	9	29	39	261	2	0.02	0	0
0450322	Prince George Jail	364	8352	3.3	0	0	1	2	9	31	39	95	0	0	0	0
E207879	Castlegar	365	8393	3.4	0	0	1	2	12	26	31	70	0	0	0	0
E221822	Port Alice Lake Road	365	8384	4.1	0	0	1	2	5	46	79	421	16	0.19	1	0.01
0260012	Trail Columbia Gardens	355	8270	5	0	0	2	7	14	29	38	178	2	0.02	0	0
E277529	Kitimat Rio Tinto Alcan KMP Camp	359	8244	5.7	0	0	1	5	16	50	65	163	0	0	0	0
E221821	Rumble Beach Hospital	365	8390	7.9	0	1	2	9	22	53	65	206	2	0.02	0	0
0250009	Trail Butler Park	365	8370	8.7	0	1	2	7	22	71	101	314	26	0.31	0	0
E257435	Birchbank Golf Course	363	8362	11.7	0	1	3	14	36	67	83	181	4	0.05	0	0
0260011	Warfield	363	8373	12.8	0	3	3	9	30	107	137	437	47	0.56	1	0.01

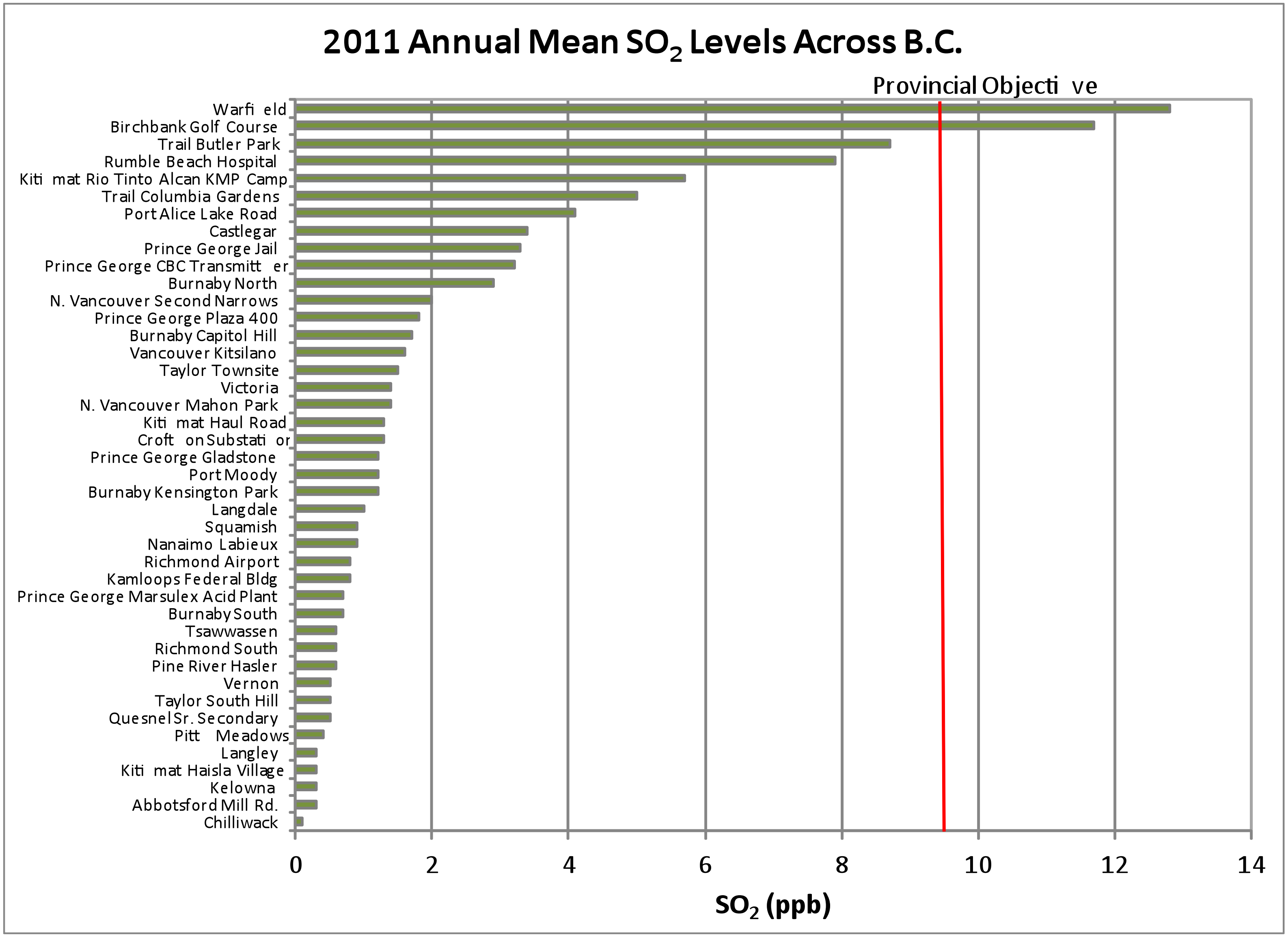

Figure A-4. Annual mean SO_2 concentrations across B.C. in 2011.