state of the AIR 2017

BC LUNG ASSOCIATION. Celebrating the Clean Air Month of June

CONTENTS

FOREWORD

Wood smoke is a major contributor to air pollution in B.C., and – similar to vehicle emissions – its health effects are detrimental to humans. Wood smoke contains fine particulate matter ($PM_{2.5}$), which can cause chronic and acute respiratory and cardiac diseases, especially among children and the elderly. It is for this reason that we devote much of the 2017 State of the Air Report to wood smoke.

Burning wood to heat homes is one of the largest sources of wood smoke in our province. During the winter, many communities approach or exceed $PM_{2.5}$ objectives due to high wood burning rates coupled with temperature inversions.

In this report, we survey the legislation, tools, and resources aimed at reducing wood smoke pollution. Previously, we reported on the Wood Stove Exchange Program, which provides incentives for replacing high-polluting wood stoves with emissions-certified alternatives. This year, we look closely at the new Solid Fuel Burning Domestic Appliance Regulation, which requires all wood-burning appliances sold in B.C. to meet the U.S. EPA's new and more stringent $PM_{2.5}$ standards.

We also feature two mobile instruments capable of more effectively characterizing residential wood smoke's effects in communities. Installed on a vehicle, these instruments can help create wood smoke maps that accurately identify hotspots.

Finally, we take a look at biomass, an important source of low-cost, renewable energy. Biomass is increasingly being used for heat and electricity. But the decrease in greenhouse gas emissions resulting from its use is often accompanied by an increase in $PM_{2.5}$ emissions. Thus, we examine whether biomass is in fact an environmental opportunity or a challenge.

This report wouldn't be complete without our Clean Air Champions. This year, we throw the spotlight on Jennell Ellis, from the community of Courtenay in the Comox Valley, and on the Cowichan Valley Regional District. Admirable and inspiring, their stories demonstrate how efforts to improve air quality in places with high $PM_{2.5}$ concentrations can start with one individual or an entire community.

In closing, I wish to thank again all the individuals and agencies whose time, energy, and dedication made this year's report possible.

SCOTT MCDONALD
President and CEO, BC Lung Association

Wood Smoke in B.C.

For many British Columbians the image of a wood stove represents warmth and tradition. However wood smoke is increasingly recognized as a major contributor to air pollution in B.C. Wood smoke is a complex mixture that contains many pollutants, including the pollutant of most concern in B.C., fine particulate matter ($PM_{2.5}$). $PM_{2.5}$ consists of tiny airborne particles that affect the heart and lungs when they are inhaled. While wood smoke may be perceived as more "natural" than other sources of pollution, a growing body of research shows that wood smoke particles are just as damaging to health as other sources of $PM_{2.5}$ such as exhaust emissions from vehicles.

The largest sources of wood smoke in B.C. are wood burning for home heating and open burning of brush and logging debris. While open burning is a very large source of $PM_{2.5}$ emissions, some of this burning takes place distant from communities. Within communities the dominant source of wood smoke is often home heating. During the winter months when most wood burning takes place, pollution-trapping atmospheric inversions are quite frequent. Wood smoke emissions combined with atmospheric inversions and B.C.'s mountain/valley topography often act to trap wood smoke near the ground, and can lead to $PM_{2.5}$ levels well above health-based objectives.

Reducing wood smoke pollution is challenging since many people in rural B.C. are dependent on wood to heat their homes.

Reducing wood smoke pollution is challenging since many people in rural B.C. are dependent on wood to heat their homes. Where natural gas is not available, wood is often the most economical source of heat. In addition, many people can gather their own wood, saving further money. Nonetheless, a number of actions have been taken at the provincial and the local level to reduce wood smoke. Recently the B.C. government adopted the new Solid Fuel Burning Domestic Appliance Regulation (see page 5), which aims to ensure that new wood-burning appliances sold in B.C. are as clean burning as possible. To hasten the move towards cleaner appliances, the B.C. Government cooperates with the B.C. Lung Association to offer the Wood Stove Exchange Program. This program offers education on clean burning practices and funds consumer incentives for switching from high-polluting wood stoves to newer appliances such as emissions-certified wood stoves, gas stoves, and electric heat pumps.

Many cities and towns in B.C. have passed bylaws with the aim of reducing wood smoke. Bylaws targeting wood smoke can include measures such as rules on what types of wood-burning appliances are allowed to be installed, restrictions on wood burning during air quality advisories, and requirements to replace old high-polluting appliances – either within a fixed timeframe or upon sale of the property. Local governments can also regulate the 'nuisance' impacts of smoke that may affect neighbours of wood burners.

At the individual level, citizens can contribute to cleaner air by choosing to heat with less polluting forms of heat, such as electric heat pumps, natural gas, or even wood pellets that burn much more cleanly than firewood. Those that heat with wood should choose a clean burning appliance and burn only clean, dry firewood.

Study of Biomass Burning and Heart Attacks in Courtenay/Comox, Kamloops and Prince George

Many studies have shown that ambient fine particulate matter ($PM_{2.5}$) is associated with adverse effects on the heart. However, relatively few epidemiological studies have specifically evaluated the heart-related impacts due to $PM_{2.5}$ from biomass burning.

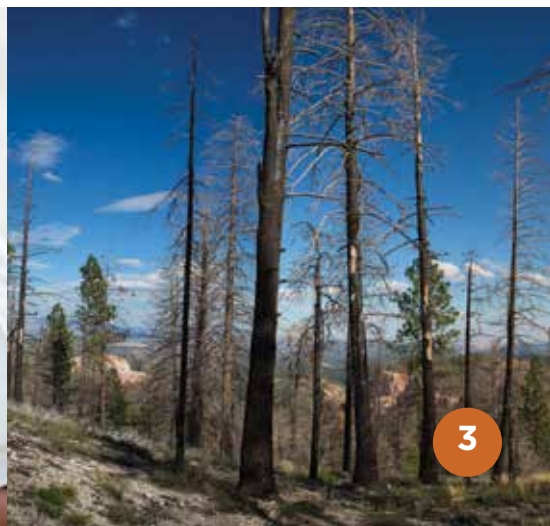
A study recently completed in B.C. examined the association between short-term changes in ambient $PM_{2.5}$ concentrations and hospital admissions for heart attacks. Possible sources of biomass burning include residential wood burning during the winter, forest fires during the summer, and burning for land clearing during spring and autumn. The study also evaluated whether the association between ambient $PM_{2.5}$ and heart attacks would be affected by the magnitude of the contribution of biomass-related $PM_{2.5}$ to overall ambient $PM_{2.5}$.

Study results showed that short-term changes in ambient $PM_{2.5}$ were associated with an increased risk of heart attack among older subjects.

The $PM_{2.5}$ –health link was assessed based on local daily hospital admission data and daily mean $PM_{2.5}$ data from provincial air quality monitors. Measurements of levoglucosan, a marker for biomass – related $PM_{2.5}$, were used to estimate the contribution of biomass burning to overall $PM_{2.5}$. Small monitoring studies were also conducted in each region from September 2014 to March 2015 to characterize variations in wood smoke contributions to $PM_{2.5}$ across each region. These data were used to develop models to adjust $PM_{2.5}$ and levoglucosan data from provincial monitors to more accurately reflect spatial variations across the regions.

On average, higher $PM_{2.5}$ concentrations were observed during colder portions of the year in all three regions. Biomass burning contributions to $PM_{2.5}$ were also generally higher during these months, consistent with residential wood burning patterns.

The study showed that short-term increases of 5 $\mu g/m^3$ in ambient $PM_{2.5}$ were associated with an increased risk of heart attacks among subjects 65 years and older, but not in the younger subjects. The association between $PM_{2.5}$ and heart attack was stronger during periods when biomass-related contributions to $PM_{2.5}$ were highest.



Estimating Wood Smoke Impacts in B.C. Neighbourhoods

Smoke from residential wood burning is a leading contributor to $PM_{2.5}$ pollution in B.C. and has shown to impact lung and heart health. During the winter heating season, many B.C. communities often approach and exceed provincial and national standards for $PM_{2.5}$ concentrations due to wood burning that occurs in locations where there is a tendency for temperature inversions to trap cold stagnant air.

The B.C. Ministry of Environment (MoE) collects valuable air quality data including $PM_{2.5}$ across the province. However, it is not feasible to maintain multiple stations in every community nor it is possible to routinely measure impacts of specific pollutant sources. This UBC-led project aims to validate a new monitoring method to more effectively measure the impact of residential wood smoke in B.C. communities with high resolution mobile equipment. Resulting wood smoke maps can be helpful to communities to identify hotspots and to support initiatives to reduce wood smoke levels.

This method uses two different instruments to measure $PM_{2.5}$ levels in the air. The nephelometer provides an estimate of total $PM_{2.5}$ concentrations. The aethalometer provides information about the composition of the particulate matter and its potential source. In particular it provides measurements that are a good indicator of wood smoke. By installing these instruments in a vehicle along with a global positioning system (GPS) and driving designated routes around a community, researchers are able to collect data on $PM_{2.5}$ concentrations and the impacts of wood smoke with high resolution such that we can map impacts across a community in a cost-effective way.

In early 2017, monitoring were conducted in three pairs of B.C. communities, each consisting of one community with an established MoE monitoring station and a nearby community with no previous monitoring history. The pairs were Courtenay/Cumberland, Whistler/Pemberton, and Vanderhoof/Fraser Lake. While analysis of these data is still ongoing, one example of the resulting highly resolved wood smoke map is seen in Figure 1. While Cumberland (bottom left of map, previously unmonitored) is a much smaller community than Courtenay that many might expect to be less smoky, data show levels are comparable between the two communities and should therefore be of equal concern.

Final analysis is being done and results will be provided to each community and associated stakeholders to inform air quality management efforts. This project would not have been possible without the funding and support received from the B.C. Lung Association, Health Canada and the B.C. Ministry of Environment.

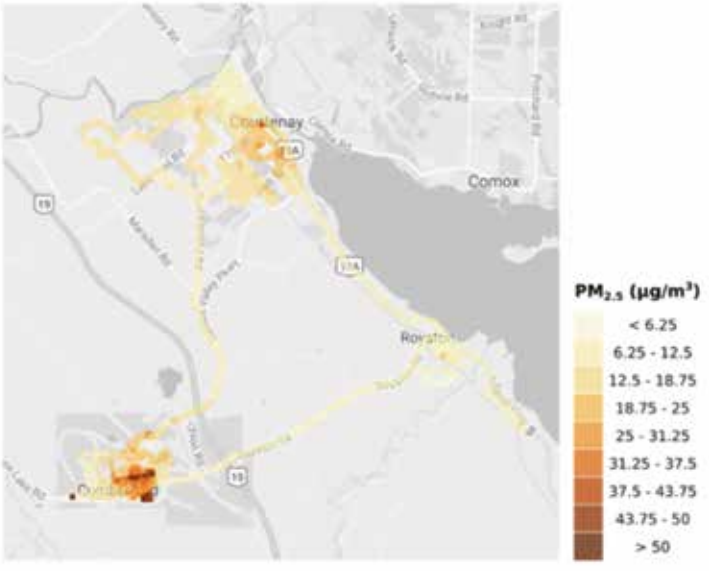


Figure 1: Courtenay & Cumberland Route - PM 2.5 Estimate

New Regulations for Wood-Burning Appliances Sold In B.C.

In September 2016 the B.C. Government adopted a new *Solid Fuel Burning Domestic Appliance Regulation (SFBDAR)*, replacing a regulation of the same name that had been in effect since 1994. The new regulation entered into force on November 1st, although some of the provisions phase in over time.

The new regulation has three main goals:

1. Ensure that new wood-burning appliances sold in B.C. are as clean burning as possible;
2. Prevent pollution problems from outdoor wood boilers;
3. Ensure appropriate fuels are used in wood-burning appliances.

The new regulation requires nearly all wood-burning appliances sold in B.C. to meet particulate matter emission standards set by the US Environmental Protection Agency (EPA) in 2015, or equivalent standards set by the Canadian Standards Association (CSA). The new standards are a 40% improvement over the existing emission standards. In addition, the emission limits will fall by a further 56% in 2020. While B.C.'s previous regulation applied to only a subset of wood-burning appliances, the new standards apply to nearly all wood-burning appliances sold in B.C. including wood-and pellet-fired furnaces, boilers, stoves, and fireplace inserts.

In addition to the new emission limits, the new regulation has provisions specific to outdoor wood boilers, a type of wood-burning appliance that has caused a number of pollution

problems. New rules limit the installation of outdoor wood boilers to locations set back from property lines. The purpose of this is to reduce the likelihood of impacts on neighbours from these relatively high-emitting appliances. To ensure that people don't buy a boiler that they can't legally install on their property, businesses that sell outdoor wood boilers are required to disclose the installation rules to purchasers. Finally, uncertified boilers will no longer be legal to use after 2026.

Burning improper fuels can cause pollution problems even from a modern low-emission appliance. The new regulation sets out a definition of "solid fuel" that includes firewood, pellets and manufactured fire logs. Only fuels that meet the regulation's definition of solid fuel are allowed to be burned. An exception is made for the use of paper or cardboard to start a fire.

The adoption of the new regulation follows extensive consultation that included an intentions paper in 2010 and a policy update in 2015.

More information on the new regulation is available at http://www.woodheating.ca/BC_Law/sfbdar_factsheet.pdf and http://www.woodheating.ca/BC_Law/sfbdar_Q+A.pdf

Forecasting Wood Smoke: Reducing Emissions from Residential Wood Burning

In B.C.'s Lower Mainland, wood smoke from home heating accounts for more than a quarter of the annual $PM_{2.5}$ emissions to the air – more than any other source (see graph). Additionally, since heating with wood is generally limited to fall and winter months, wood smoke can contribute an even larger proportion of the fine particles that residents inhale on a seasonal basis.

Smoke can build up when calm, still air prevents smoke from dispersing, particularly in winter and overnight, even when clean-burning techniques and modern devices are used. Smoky outside air can also be drawn into fresh-air furnace intakes or open

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(Cont'd from p.5 - Forecasting Wood Smoke)

windows causing fine particle levels inside the homes of wood burners and their neighbours to increase.

In Metro Vancouver, a new tool is available to help wood-burning households minimize the potential impacts of wood-burning on neighbours. Each day, regional forecast weather conditions for the next 24 hours are used to develop "burning forecasts" of whether wood smoke is expected to dissipate. The forecast is available to residents through Metro Vancouver's air quality phone line (604-436-6777). After selecting your municipality, a message provides advice that either:

- burning is not recommended;
- you should check to see whether your smoke is affecting your neighbours; or
- best wood-burning practices should be used to minimize smoke impacts.

By following the burning forecast guidance provided, or taking other actions to reduce wood smoke emissions, air quality in neighbourhoods can be improved and the risk of health impacts reduced.

Meeting Energy Needs with Biomass – An Environmental Opportunity or Challenge?

The use of biomass to provide heat and electricity is increasing in B.C. Systems are in place in many places like UBC, UNBC, Dockside Green in Victoria, Burns Lake, Williams Lake, Enderby, Lillooet, Mackenzie, and Revelstoke, and many new facilities are proposed. So what's behind the increasing adoption of these systems? And what does it mean for air quality?

- Lower Cost: An economic source of heat or power, particularly in areas off the natural gas "grid" that would otherwise rely on oil, propane or electricity for heat.
- Beneficial Use: A solution to forest or agriculture waste disposal, in cases where biomass is sourced as a by-product that would otherwise be wasted.
- Reduced Greenhouse Gas Emissions: An opportunity for municipalities, universities, schools and hospitals to reduce greenhouse gas (GHG) emissions and move closer to carbon neutrality.
- Increased $PM_{2.5}$ Emissions: Reduced GHG emissions can be accompanied by increases in $PM_{2.5}$ emissions, so emission controls are required for facilities.

Generating energy from biomass often means burning biomass in a boiler to generate heat and/or power. Although many forms of biomass can be burned, the most common fuels in B.C. are woody biomass including conventional firewood, waste wood from timber and wood products industries, or chipped or pelletized wood. Modern biomass boilers include technology to optimize the combustion and emissions control equipment. Heat from biomass combustion can be used for industrial purposes, in addition to space and water heating.

Biomass is an important source of renewable electricity in Canada, and in B.C. Of the approximately 2,000 megawatts (MW) in biomass-based generating capacity in Canada in 2014, over 40% was produced in B.C. The most common technology used in B.C. is the conventional boiler, often in combination with steam turbines for electricity generation. One example is a 36 MW bioenergy facility in Mackenzie, B.C. that burns 500 tonnes of biomass per day, ranging from sawmill residuals like hog fuel (e.g., bark and outside portions of cut logs) to wood shavings and chips. Biomass electricity plants exist in a wide range of sizes. Larger plants are often located adjacent to wood processing facilities or pulp and paper mills. The adjacent industry may provide a ready supply of waste biomass and also use the waste heat from electricity generation. Smaller

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(Cont'd from p.6 - Meeting Energy Needs with Biomass)

biomass electricity generators may be attractive in communities dependent on expensive diesel generators. An example is the 145 kilowatt combined heat and power plant proposed to be installed in the remote Kwadacha First Nation.

Biomass is also used for heating. Before 2000, there were only five biomass heat installations in Canada, none of which were in B.C. However, since 2007/2008, development has accelerated and by 2013 there were 109 systems operating in Canada, led by 30 in B.C. Our province has many small to medium-sized commercial biomass boilers (i.e. ranging from 100 kilowatts to 3 MW in capacity). A big driver for these boilers is provincial policies that require public institutions in B.C. to be carbon neutral. Organizations using biomass for heating can reduce their fossil fuel use, helping to meet their climate change goals.

Fuel quality, technology, emissions controls and cost are important parameters in operating a biomass system. For example, organizations aiming for carbon neutrality often burn higher quality fuel (e.g. pellets or high quality wood chips) that costs more, but can equate to simpler operation and reduced emissions. Conversely, boilers burning forest waste – tens of millions of tonnes of which is burned every year in B.C. – are typically burning lower quality fuel. Though the fuel is cheap, poor fuel quality usually means increased emissions that require more costly emissions control technology. Increasing use of biomass can lead to increased local air pollution and associated health effects. This is because, while

Fuel quality, technology, emissions controls and cost are important considerations in operating a biomass system.

modern biomass boilers can be quite clean burning, they still produce greater emissions of particulate matter and other pollutants, in comparison to alternatives such as natural gas.

In most areas of B.C., emissions rules are set by the Ministry of Environment, while in Metro Vancouver, the Metro Vancouver Regional District establishes emissions requirements. Some biomass projects trigger permit requirements in B.C., for example if the heat is used as part of a larger facility that requires a permit. In those cases, it's likely that project proponents would be required to operate using "best achievable technology", which requires use of technology that can achieve the best emissions discharge standards, and that has been shown to be economically feasible through commercial application. Depending on the size of the system, emission control technology can be a significant economic challenge to its operation. For small boilers, the cost of emission control technology can be a significant proportion of the total cost of the project.

As in many emerging areas, there is also regulatory uncertainty for biomass heating. When a biomass system is used exclusively to provide comfort heat, its operation may be exempt from requirements to obtain a provincial permit under the *B.C. Environmental Management Act*. However, if a biomass system was causing "pollution" under the Act (defined as "the presence in the environment of substances or contaminants that substantially alter or impair the usefulness of the environment"), action to reduce the emissions could still be required. While concerning, this apparent regulatory gap for biomass boilers is the focus of ongoing work by the province to develop guidance on emission standards and best practices. In Metro Vancouver, all biomass boilers under 50 megawatts are regulated under bylaw, with stringent emission control requirements, while larger boilers are required to obtain an air quality permit.

As biomass heating continues to grow, B.C. legislators will continue to address this emerging area through appropriate air quality regulation and policies. It's important to compare the economic costs of biomass systems with the public health benefits of properly controlled emissions. Consideration of heating technologies, fuel types and emissions control options will allow operators of biomass systems and decision-makers to establish optimal systems that meet economic, environmental and health goals for the location.

Clean Air Champions

Cowichan Valley Regional District and Partners

Cowichan Valley was one of the communities in the first Air Zones reports that exceeded the national $PM_{2.5}$ standards[1]. Air quality in the Cowichan Valley has been a growing concern in recent years. To respond to these concerns, the Cowichan Valley Regional District recently finalized its Cowichan's Regional Airshed Protection Strategy. This plan was created by a cross-jurisdictional roundtable of local government, First Nations, residents, health professionals and elected local government board members. It identifies $PM_{2.5}$ as the contaminant of greatest concern and focuses actions on reducing $PM_{2.5}$ emissions from sources such as open burning and wood-burning appliances.

The Region was a recipient of PlanH funding which was used to engage two professional facilitators and organize three change management sessions to assist in plan implementation. PlanH is a partnership between the B.C. Healthy Communities Society and Healthy Families B.C., which "supports local engagement and partnerships across sectors for creating healthier communities."

Our Cowichan Communities Health Network is currently acting as group facilitator for ongoing works of the roundtable as the various groups move forward on implementation of the strategy. This work includes facilitation and coordination of work groups and bi-annual meetings. Implementation of the strategy is expected to have a positive impact on ambient $PM_{2.5}$ levels in the region.

Additional activities within the Cowichan Valley to reduce $PM_{2.5}$ emissions and increase public awareness include:

- Participation in the Provincial Wood Stove Exchange Program.
- Publication of five articles on wood smoke in the Cowichan Valley Citizen and online.
- Partnership with various agencies to conduct mobile monitoring of $PM_{2.5}$ and to develop an emission inventory.
- Evaluation options to reduce open burning.

Under the national Air Quality Management System, air zones are the basis for monitoring, reporting and taking action on air quality. The Ministry of Environment has identified seven broad air zones across the province. In the first air zone reports, the Central Interior and Georgia Strait Air Zones were assigned "red" management levels for $PM_{2.5}$, indicating that the national air quality standards had been exceeded and that actions should be undertaken to reduce $PM_{2.5}$ levels.

[1] *(http://www2.gov.bc.ca/gov/content/environment/air-land-water/air/air-quality-management/aqms)*

Fighting for Clean Air in the Comox Valley

Less than two years ago, Jennell Ellis and her partner, Mike Mason, left the Yukon to move to Vancouver Island's Comox Valley.

Three weeks after unpacking the UHaul, Jennell was surprised to read a story in the local paper about a B.C. government report that identified their new community of Courtenay as the worst of 13 towns in the Georgia Strait Air Zone for fine particulate pollution. She learned much of the pollution came from wood smoke.

"We moved into an older neighborhood where many homes use wood stoves for heating," explained Jennell. "In our first winter, we had four multi-day air quality advisories. Our lungs often ached and we could smell smoke inside our home."

Jennell and Mike started connecting with people from different parts of the Comox Valley who were also concerned about the air quality. After a few months of networking and research, they formed Breathe Clean Air Comox Valley.

"One of the main things we do is educate people about the very serious health impacts of wood smoke. As people realize how harmful smoke is to their health, we believe they will be more open to switching to cleaner sources of heat and to supporting broader changes," explained Jennell.

"Both newcomers and old timers are sharing stories about how wood smoke impacts their health or affects their lifestyle in some way," Jennell added. "And others who had never thought about wood smoke are now noticing it and realizing that, just

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(Cont'd from p.8 - Clean Air Champion: Fighting for Clean Air in the Comox Valley)

like second hand cigarette smoke, it must be harming them and their families."

Momentum for the group and its work has been fueled by numerous winter air quality advisories. Additionally, further research has made it clear that the Comox Valley's wood smoke issue is significant and is impacting people's health.

"Our group is working on getting local government representatives to acknowledge there is a serious problem that they have the power–and responsibility–to do something about," continued Jennell. "Progress is slower than we'd like, but we're hopeful regulations will be adopted that will reduce wood smoke and allow people to protect their own homes from encroaching smoke."

"I'd much rather be doing other things with my time but if I am going to keep living here–which I really want to do–I need to feel like there is hope that the air quality will improve."

The Comox Valley is not the only community on Vancouver Island to be dealing with wood smoke issues. For example, the Port Alberni area has had an Air Quality Council since 2003 and the Cowichan Valley recently completed an Airshed Protection Strategy.

"I've learned that concerned citizens throughout B.C. are dealing with the same issue, community by community. Jennell feels that the province needs to take greater leadership on this issue, to protect the health of all B.C. citizens, no matter where they live.

For now, Jennell Ellis dedicates a lot of her spare time fighting for clean air in her area. A communications professional by trade, she uses her skills to amplify the voices of all those affected in her community. She developed a website, writes educational materials, manages an active Facebook group, and is the group's spokesperson and coordinator.

"I'd much rather be doing other things with my time but if I am going to keep living here–which I really want to do–I need to feel like there is hope that the air quality will improve."

pollution levels
how does B.C. measure up?

Weather has a major influence on air quality levels in B.C. In 2016, much of the province experienced warm, dry and in some cases, dusty conditions during the spring, followed by moderate levels of rain between June and August[2,3]. This rain helped to prevent the drying out of forest fuels and reduce the potential for summer wildfires. As a result, no wildfire-related smoke advisories were issued during the summer of 2016, compared to 24 advisories the previous year. In December, a persistent high pressure system over western Canada brought cold, stable conditions to B.C. This resulted in a build-up of $PM_{2.5}$ levels and the issuance of $PM_{2.5}$-related air quality advisories in a number of communities on Vancouver Island and across central B.C.

In the following sections, air quality data from several monitoring sites are summarized and compared against provincial or national objectives that provide benchmarks to assess air quality[4]. Due to lack of space, the summary plots focus on those sites that best reflect community air quality and where possible, the range of conditions across a community[5]. In some cases (e.g. Rolla and Blueberry River) the monitors are part of a special short-term surveillance study in the northeast. Data from all available monitoring sites are summarized in the Technical Appendix.

$PM_{2.5}$ Fine Particulate Matter

Fine particulate matter refers to microscopic particles that are 2.5 micrometers or smaller in diameter. $PM_{2.5}$ is known to affect respiratory and cardiovascular health. Major sources of $PM_{2.5}$ in B.C. include open burning, wildfires and residential wood stoves. Other important sources include marine vessels and diesel vehicles.

$PM_{2.5}$ was continuously monitored at more than 60 stations in B.C. in 2016. Most of the old TEOM instruments (Tapered Element Oscillating Microbalance) have now been replaced by Federal Equivalent Method (FEM) monitors that provide a more complete measure of $PM_{2.5}$. Annual average con-

[2] *http://www.cmos.ca/site/top_ten?language=en_CA&a=2016.*
[3] *http://www2.gov.bc.ca/gov/content/safety/wildfire-status/wildfire-statistics/wildfire-season-summary.*
[4] *http://www2.gob.bc.ca/assets/gov/environment/air-land-water/air/reports-pub/aqtable.pdf/*
[5] *For more information on Northeast air quality characterization study, see: http://www2.gov.bc.ca/gov/content/environment/air-land-water/air/air-quality/measuring/monitoring-ne-bc.*

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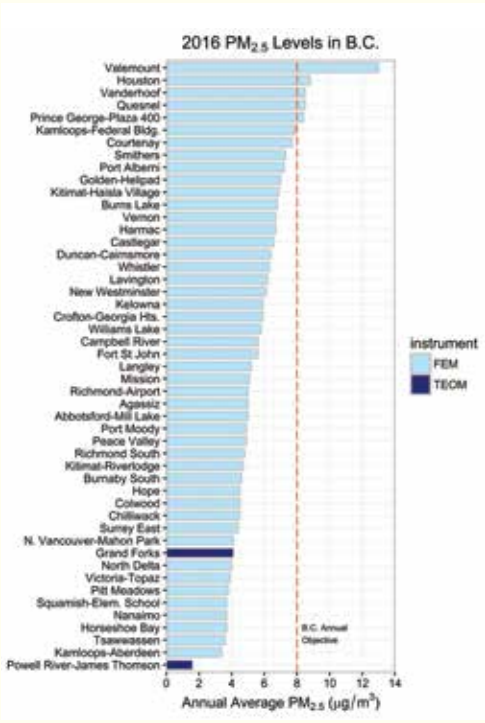
centrations ranged from 1.6 µg/m³ in Powell River to 13 µg/m³ in Valemount. A total of five monitored communities exceeded the provincial annual average objective of 8 µg/m³: Valemount, Houston, Quesnel, Vanderhoof and Prince George. In addition, four communities equalled or exceeded the provincial 24-hour objective of 25 µg/m³ (not shown): Valemount, Vanderhoof, Courtenay and Houston. Aside from wild fires, elevated $PM_{2.5}$ levels are typically associated with wood combustion and stagnant weather conditions that temporarily trap cold air and pollutants in valley bottoms.



SO_2 Sulphur Dioxide

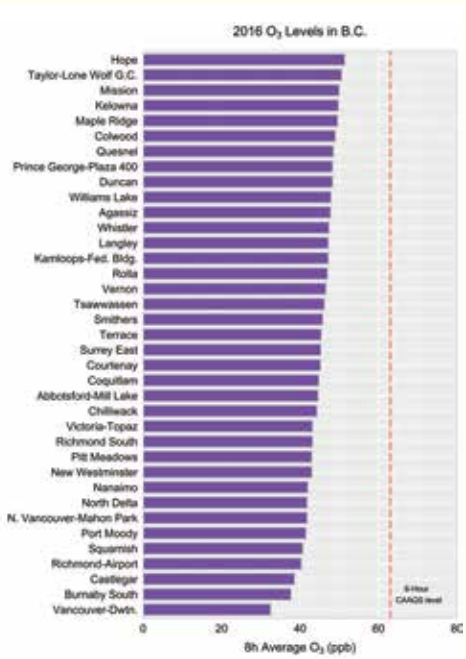
Sulphur dioxide (SO_2) is a colourless gas with a pungent odour at higher concentrations. Short-term exposures to elevated levels can aggravate asthma and increase respiratory symptoms. The major sources of SO_2 in B.C. include the upstream oil and gas industry, metal smelting facilities, pulp mills and marine vessels.

SO_2 was monitored at more than 55 stations in 2016. Daily 1-hour maximum concentrations ranged from 1.6 ppb in Kelowna to 207 ppb in Trail. The majority of stations reported SO_2 concentrations below 5 ppb. Based on 2016 data only, Trail was the only community to exceed the provincial objective level of 75 ppb[6]. The major source of SO_2 emissions in this community is the lead-zinc smelter. Large reductions in SO_2 emissions from this facility were achieved with the introduction of the Kivcet smelter in the late 1990's but short periods of elevated SO_2 levels are still observed. A new acid plant, which was forecast to reduce overall SO_2 emissions by 15%, began operating in 2014. A second new acid plant is scheduled to begin operating in 2019, and is expected to reduce emissions by another 5%. The smelter has committed to continued emissions reductions over the long term, striving toward attainment of the objectives.

O_3 Ground-level Ozone

Ground-level ozone (O_3) is a reactive gas that is formed in the air from reactions involving nitrogen oxides (NOx) and hydrocarbons in the presence of sunlight. Motor vehicles are a major source of both types of pollutants. Ozone exposure is linked to breathing difficulties, aggravation of asthma and other lung diseases and premature deaths. Ozone also has direct and indirect effects on vegetation.

Ozone was monitored at 45 sites in the province in 2016, with the majority located within the Lower Fraser Valley (LFV). Eight-hour ozone concentrations ranged from 35 ppb in downtown Vancouver to 51 ppb in Hope[7]. All monitoring sites were well below the level of the Canadian Ambient Air Quality Standard of 63 ppb.

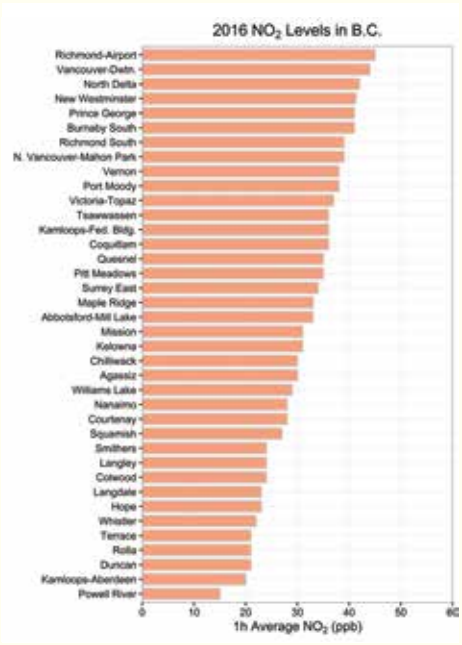


[6] *Based on annual 97th percentile of daily one-hour maximum. Provincial 1-hour objective of 75 ppb based on similar form, averaged over three years (2015-2017).*
[7] *Based on annual 4th highest daily 8-hour maximum over one year. The national standard is based on this form, averaged over three years.*

NO_2 Nitrogen Dioxide

Nitrogen dioxide (NO_2) is a reddish-brown gas that is associated with high-temperature combustion processes such as found in motor vehicles and industrial processes. Short-term exposures are associated with respiratory illness, and there is growing evidence that links NO_2 exposure to other health effects such as cardiovascular mortality, cancer and reproductive effects.

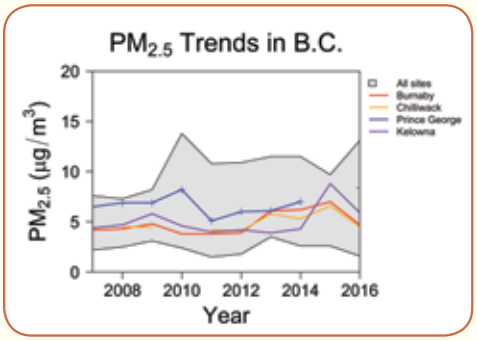
NO_2 was monitored at 50 sites in 2016. The majority of these sites were located in the LFV. One-hour concentrations ranged from 14 ppb in Powell River to 45 ppb at the Richmond-Airport site and were well below the provincial objective of 100 ppb[8]. Annual mean concentrations (not shown) ranged from 1.2 ppb in Powell River to 18.5 ppb in downtown Vancouver, and were below the current provincial objective of 32 ppb. The highest concentrations were generally observed in areas of Metro Vancouver that are close to busy transportation routes. It is noted that new national NO_2 standards are under development and that the provincial NO_2 objectives will be re-evaluated once the national standards are adopted.



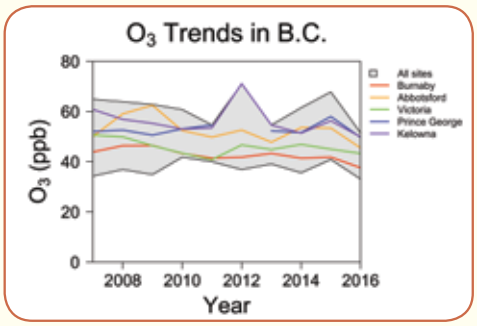
trends air pollution in B.C. through the years

Trends are tracked to gauge the effectiveness of actions already implemented and to determine if there is a need for further action to protect future air quality. The following figures compare 10-year trends in annual concentrations at specific monitoring sites with the range of minimum and maximum concentrations observed across the province.

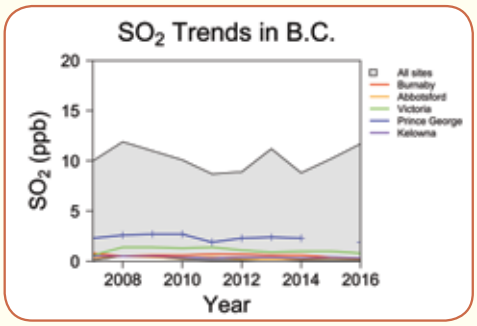
Year-to-year variations in $PM_{2.5}$ levels are a reflection of several different factors, including changes in emissions, meteorological conditions, impacts from wildfire smoke, and changes in monitoring technology. For example, the shift to the FEM monitors, which provide a more complete measure of $PM_{2.5}$, is reflected in the bump upwards in reported $PM_{2.5}$ concentrations in 2013 in Burnaby and Chilliwack and 2015 in Kelowna. The influence of wildfire smoke is seen in higher $PM_{2.5}$ levels in Prince George in 2010 and in Kelowna in particular in 2015.



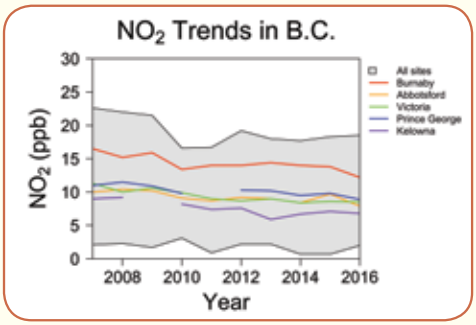
Recent studies in southwestern B.C. indicate that wildfire emissions can also boost ozone concentrations under certain conditions[9]. As an example, elevated concentrations in Kelowna in 2012 have been associated with smoke from the Siberian wildfires. Within the Lower Fraser Valley, where the highest ozone levels have been observed, there is some evidence that peak concentrations are decreasing.



Annual average SO_2 levels remain low in urban areas of B.C. due to ongoing efforts to reduce the sulphur content in motor vehicle and marine fuels, and reduce emissions from the petroleum products industry in Metro Vancouver.



Annual average NO_2 levels have generally declined over the past decade, due to reduced emissions from motor vehicles and the former AirCare vehicle inspection and maintenance program in the LFV. However, concentrations appear to have leveled off more recently. The implementation of new Tier 3 vehicle emission standards beginning with the 2017 model year is expected to result in further reductions in NO_2 levels as new motor vehicles join the fleet.



[8] *Based on the annual 98th percentile of the daily 1-hour maximum over one year.*
[9] *Teakles, A.D., So, R., Ainslie, B. et al. (2017) Impacts of the July 2012 Siberian fire plume on air quality in the Pacific Northwest. Atmos. Chem. Phys. 17, pp. 2593-2611.*

updates
from partner agencies

Health Canada / Santé Canada

Air Quality Health Effects:

Health Canada recently completed two human health risk assessments:

- The potential adverse health effects associated with diesel exhaust emissions from on-road and off-road vehicles in Canada were evaluated in the Human Health Risk Assessment for Diesel Exhaust. Based on the available scientific evidence, it was concluded that diesel exhaust is causal in the development of cancer and adverse respiratory effects, and is likely to be causal in the development of adverse cardiovascular and immunological outcomes. It was also concluded that diesel emissions result in significant and substantial population health impacts and societal costs in Canada via the contribution of diesel exhaust to ambient concentrations of criteria air contaminants. Therefore, it was recommended that efforts continue to further reduce emissions of and human exposures to diesel exhaust.

- A human health risk assessment of sulphur dioxide (SO_2) was completed in order to update the available information on adverse effects of SO_2 to human health and determine recent Canadian SO_2 exposure levels. Potential health risks to the Canadian population were identified from exposures to ambient concentrations of SO_2, which are below the current National Ambient Air Quality Objectives. The results of the risk assessment were used to inform the development of new Canadian Ambient Air Quality Standards (CAAQS) for sulphur dioxide that will drive the improvement of air quality across the country.

In collaboration with several Canadian universities and public health organizations, Health Canada has completed research projects looking at exposure to air pollutants and aeroallergens and their effects on health:

- Daily changes in aeroallergens during pregnancy could trigger early labor, but few studies have evaluated this issue. Based on 225,234 single births that occurred in six large cities in the province of Ontario, Canada, from 2004 to 2011, exposure to aeroallergens during pregnancy was evaluated among preterm and term pregnancies. This study showed that daily changes in ambient weed pollen and fungal spores may be associated with earlier delivery among term pregnancies.

- A population based study in Ontario, Canada among 2,350,898 single live births occurring between 1988 and 2012 examined whether prenatal and early life exposures to ambient air pollutants were associated with specific childhood cancers. Results show that $PM_{2.5}$ exposure in the first trimester was associated with risk of astrocytoma (a type of brain cancer) during childhood while first trimester exposure to NO_2 increased risk of acute lymphoblastic leukemia.

Reducing Exposure to Air Pollution

Health Canada recently completed a study to test the effectiveness of two interventions aimed at improving indoor air quality in homes with attached garages. The first intervention was the installation and use of an exhaust fan in the garage to reduce the transfer of pollutants from the garage into the home. The second intervention was the improvement of the seal between the home and the attached garage by identifying and remedying leakage areas in the connecting wall. Mechanical ventilation was found to be a feasible and effective option for reducing indoor levels of pollutants originating from the garage. Results of the sealing intervention are expected to be published soon.

Air Quality Health Index (AQHI)

Health Canada continues to promote public awareness of the AQHI, a tool that helps Canadians become aware of local air quality conditions and actions they can take to reduce their exposure to air pollution. The AQHI is available on-line at airhealth.ca for communities across Canada or at http://www.env.gov.bc.ca/epd/bcairquality/readings/aqhi-table.xml for communities within BC. A national AQHI mobile app is available for free download via the Google Play Store, iTunes or by visiting airquality.alberta.ca.

In collaboration with Clean Foundation, Health Canada has developed the on-line Super Eddie Enviro games for young children, families and teachers looking to learn about the importance of clean air and renewable energy and what everyone can do to keep their communities clean. The games are available on-line at http://clean.ns.ca/super-eddie-games/ and as apps on android and iOS.

metrovancouver

SERVICES AND SOLUTIONS FOR
A LIVABLE REGION

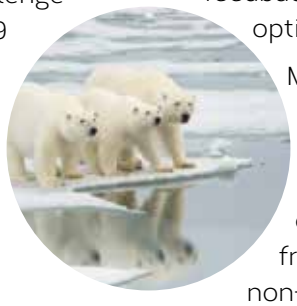
Updating Our Air Quality and Greenhouse Gas Plan

Metro Vancouver will begin development of an update to the Integrated Air Quality and Greenhouse Gas Management Plan (IAQGGMP) later this year. Adopted in 2011, the IAQGGMP sets out a vision, goals and actions for managing air quality and addressing climate change in the region. The first regional Air Quality Management Plan was adopted in 1994, followed by a second plan in 2005, which included goals to improve visual air quality and reduce the region's contribution to climate change.

Action on Climate Change

Metro Vancouver continues to deliver climate change initiatives in 2017, and at the same time is developing a broad-reaching strategy on our response to climate change.

In late-2016, Metro Vancouver offered the Smart Drive Challenge, a study that recruited drivers to have a "smart" plug-in device fitted in their vehicles to track real-time vehicle performance. The Challenge successfully trained 159 members of the public to drive better and drive less. In 2017, findings from the Challenge will be used to inform development of future programs.



In 2016, Metro Vancouver launched the RateOurHome.ca website, which is promoted to homebuyers and industry alike, highlighting the importance of home energy labelling as a decision-making tool when purchasing a home. In 2017, the region's real estate agents will be actively engaged on how to use the label and the importance of energy efficiency. Work is also underway to remove barriers to increasing the number of EnerGuide rated homes shown on the RateOurHome.ca map.

Regulatory Updates: Wood Smoke and Non-Road Diesel

Residential wood smoke is a significant issue in the Metro Vancouver region, leading to both poor air quality and health effects. A survey of residents across the region indicated that approximately 100,000 fireplaces and wood stoves could be in use, resulting in residential indoor wood burning contributing more than a quarter of emissions of fine particulate matter on an annual basis in Metro Vancouver.

Metro Vancouver initiated consultation on reducing emissions in the region from residential indoor wood burning in early 2017. Events were held in spring 2017 for businesses, health experts, members of the public who heat with wood, and members of the public affected by wood smoke, to provide input and feedback about potential regulatory options.

Metro Vancouver is proposing changes to its Non-Road Diesel Engine Emission Regulation Bylaw, which focuses on reducing emissions from older, higher-polluting non-road diesel engines. Diesel exhaust is a significant source of fine particulate matter emissions, and is a primary contributor to short- and long-term air quality health concerns, such as aggravated asthma, and heart and respiratory diseases.

The proposed bylaw amendments mainly affect engines registered for "low-use", and are expected to improve reporting of low-use operating hours and compliance, as well as create a more level playing field. Visit www.metrovancouver.org/services/air-quality/consultation for more information.

Electric Vehicle Programs

Setting up electric vehicle (EV) charging in stratified multi-family buildings (condos, apartments and townhomes) is a complex process, involving EV owners, strata councils and property managers, as well as building residents. As about half of Metro Vancouver's population lives in multi-family dwellings, this presents a real challenge for EV uptake.

Metro Vancouver launched EVCondo.ca, a website with information on the process of setting up EV charging. The website includes an online map of buildings with EV charging infrastructure, basic facts about EVs and EV charging, EV charging cost information, case studies of buildings that have successfully installed EV charging, and links to resources, such as certified electrical contractors, strata lawyers or incentive programs.

EVCondo.ca complements Metro Vancouver's other electric vehicle outreach work, including the Emotive campaign and a new initiative to establish a workplace charging program.

Caring for the Air

Metro Vancouver's annual Caring for the Air Report has air quality stories at www.metrovancouver.org/air.

(Cont'd from p.13 - Updates: From Partner Agencies)

Environment and Climate Change Canada

Environnement et Changement climatique Canada

Right: Environment Canada's mobile air quality research platform.

Environment and Climate Change Canada has a mandate to provide Canadians with a clean, safe and sustainable environment. This is achieved through a variety of programs such as the Clean Air Regulatory Agenda, the Air Quality Management System and the Canada-US Air Quality Accord. In the Pacific-Yukon region, Environment and Climate Change Canada is involved in a number of long and short-term studies. These include:

National Visibility Monitoring

Environment and Climate Change Canada continues to run the National Visibility Monitoring Initiative aimed at assessing visibility conditions in border areas of Canada. The initiative includes a monitoring component with multiple sites in the Lower Fraser Valley of B.C., a site in Egbert, Ontario, and one in Wolfville, Nova Scotia. Current activities include a comparison of visibility conditions across Canada using data from the National Air Pollution Surveillance (NAPS) speciation network, intercomparison studies with the NAPS and CAPMoN networks and the development of a forecasting tool for visibility conditions.

The Lower Fraser Valley monitoring sites are operated in partnership with Metro Vancouver. Visit: http://www.clearairbc.ca/visibility/Pages/default.aspx for more information on the collaborative approach to improving visual air quality in B.C. and the work of the of the B.C. Visibility Coordinating Committee.

A

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AQ Monitoring at a Marine Boundary Layer Site

A joint EC/BC Environment/Metro-Vancouver background monitoring site at Ucluelet, on the west coast of Vancouver Island, has been collecting data on background air quality data since 2010. Scientists have carried out various studies at the site including, characterization of marine boundary layer chemistry, characterization of long-range transport of pollutants from Asia and assessing the effect of MARPOL Annex VI Marine Emission Control Area regulations on sulphur dioxide and sulphate. New analyses have been completed over the past year on the routine monitoring data, on the role of marine aerosols as cloud condensation nuclei, the role of halogens in ozone chemistry and on ozone depletion events. Data from Ucluelet indicate that SO_2 levels from ocean-going ship emissions have declined since the implementation of international regulations under the Emission Control Area.

A Mobile Air Quality Research Platform

Environment and Climate Change Canada's mobile trailer, specialized for carrying out complex chemical process studies, was deployed at Clark Drive in Vancouver as part of the National Air Pollution Surveillance Near-Road Study. The study, led by Environment and Climate Change Canada in partnership with the University of Toronto and Metro Vancouver, aims to understand air quality and health impacts near major urban roads by measuring ultrafine particles, real-time volatile organic compounds and other components of urban smog which are not captured as part of routine measurements by Environment Canada's National Ambient Air Pollution network. Analysis of data collected from this study has begun.

Air Quality Modelling to Inform Air Quality Management

Statistical modelling studies have been carried out over the past year to analyze the effect of large-scale emission reductions in the Lower Fraser Valley on ozone concentrations over the past three decades. Results indicate that ambient ozone levels have declined but at a lesser rate than precursor emissions (VOCs and NOx). Recommendations have been made to Metro Vancouver on management strategies tailored for different parts of the airshed.

Photochemical modelling studies were carried out by Environment Canada over the past year to understand the role of fugitive VOC emissions in ozone and particulate matter formation in the Lower Fraser Valley area. This study will help inform possible additional actions to further reduce the impact of marine pollution on air quality.

For more information on regional air quality research carried out by Environment and Climate Change Canada please see the 2014 Georgia-Basin/Puget Sound Airshed Characterization report at: http://www.ec.gc.ca/air/default.asp?lang=En&n=1F36EFBB-1t

(Left): A view looking southeast over British Columbia's Lower Fraser Valley at Chilliwack. Photo courtesy: Environment Canada. (A) On a clear day (25 September 2010 at 4:30PM PDT) with $PM_{2.5}$ values of 1.1 µg/m^3 and aerosol optical thickness t = 0.062, giving 94 percent light transmission. (B) On a day when particulate matter and other pollutants reduce visibility (5 August 2010 at 1:30 PM PDT) with $PM_{2.5}$ values of 24.6 µg/m^3 and an aerosol optical thickness, t = 0.964, giving 38 percent transmission

Fraser Valley Regional District (FVRD)

Ambient Ammonia in the FVRD

NH_3

The FVRD completed a comprehensive review of atmospheric ammonia in the region. The study analyzed ammonia emissions and emission forecasts from all sources, ambient monitoring data, and potential impacts on human and ecosystem health. In collaboration with air quality experts from partnering agencies, a set of recommendations was developed to better understand the sources and spatial distribution of ammonia, emission reduction options, including Best Management Practice; and the potential role ammonia plays in the formation of secondary particulate matter.

Wood Burning Emissions

The FVRD is currently reviewing options for developing alternatives to open burning, such as wood waste chipping and hauling, residential drop off, or composting. The Woodstove Exchange Program continues in 2017 providing a rebate to the residents replacing their existing stoves and fireplaces with modern, certified appliances. Since the launch of the program in 2009, 241 old wood-burning stoves have been exchanged in the FVRD, which translates to a reduction of 3.8 tonnes of fine $PM_{2.5}$.

Engine Emission Reduction

The FVRD is in the process of developing programs and policies for further emission reduction from the on-road and non-road vehicles with the focus on volatile organic compounds and nitrogen oxides. Those compounds are identified as pre-cursors to ground-level ozone formation and specifically targeted under the Regional Ground-Level Ozone Strategy (RGLOS). As a part of its "leading by example" initiative, the FVRD is also currently monitoring performance of its corporate fleet with the focus on the vehicle communications technology and driving patterns. This will help determine suitability of the existing gasoline cars and trucks for potential future replacement with Electric Vehicles (EV). The FVRD continues to promote and add EVs to its fleet. By the end of 2017, four electric cars with the FVRD logo will be on the roads.

BRITISH COLUMBIA | Ministry of Environment

Regulatory Updates

The province adopted the new Solid Fuel Burning Domestic Appliance Regulation (SFBDAR) in September 2016 to ensure new appliances sold in BC are as clean-burning as possible. For more information on changes to this regulation, see page 5.

New National Air Quality Standard

In October 2016, B.C. joined other jurisdictions across Canada in endorsing new Canadian Ambient Air Quality Standards (CAAQS) for sulphur dioxide (SO_2) for 2020 and 2025 achievement. For more information on the SO_2 CAAQS, see: http://www.ccme.ca/en/resources/air/air/sulphur-dioxide.html.

Air Quality Monitoring Network

As part of the B.C. Northeast Air Quality Monitoring Project, air quality monitoring trailers were moved to three new locations near Taylor, Rolla and at Blueberry First Nations School.

Provincial Wood Stove Exchange Program

In 2016, the province provided $200,000 in funding to 14 B.C. communities or regional districts to support the change-out of older wood stoves with cleaner-burning heating options such as heat pumps, gas stoves or new EPA-certified wood stoves. A new call for proposals for funding will take place in the fall of 2017. For more information, see: http://www2.gov.bc.ca/gov/content/environment/air-land-water/air/air-pollution/smoke-burning/exchange.

Prince Rupert Airshed Study

Given the number of potentially new, large sources of air emissions in the Prince Rupert airshed, the province funded an independent modelling study to better understand any potential air quality impacts to this area. The results of the study showed that the Prince Rupert airshed could accommodate further industrial development with proper management[10].

[10] *https://news.gov.bc.ca/releases/2016ENV0052-001866*

visit/contact

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outside the Lower Mainland)

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Vancouver, B.C. V6C 3S5
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HEALTH PROGRAM - B.C. REGION
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index-eng.php
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B.C. MINISTRY OF ENVIRONMENT
http://www2.gov.bc.ca/gov/content/
environment/air-land-water/air

Environmental Standards Branch
PO Box 9341, Stn Prov Govt
Victoria, B.C. V8W 9M1
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Ministry of Environment
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www.env.gov.bc.ca/main/
regions.html

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http://www2.gov.bc.ca/gov/con-
tent/governments/organizational-
structure/ministries-organizations/
ministries/health
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technical appendix

2017 BC Lung State of the Air Report -- Technical Appendix

Data Source:

B.C. Ministry of Environment and Metro Vancouver

Units:

All data presented in ppb except $PM_{2.5}$, which is presented in micrograms per cubic metre

Monitoring sites:

Monitoring is often conducted to address various objectives that may include measuring concentrations representative of: community exposure, industrial impacts, background concentrations, etc.

For the State of Air Report, monitoring sites immediately adjacent to industrial facilities were not included unless these sites were also near areas of high population density.

Data completeness:

Data completeness criteria have been relaxed relative to previous reports to enable reporting of data from more stations.

In this report, a valid day has data for at least 18 hours (75%).

A valid year has data for at least 60% of days in each quarter and 75% of of hours over an entire year, with the following exceptions.

For peak (4th highest) 8-hour ozone levels, a valid 8-hour period has data for at least 6 hours, a valid day has data for at least 18 hours, and a valid year has at least 75% of days in the second and third quarters (April 1 to September 30).

For peak (1-hour) SO_2 and NO_2 levels, a valid daily maximum includes those days where less than 18 hours are available in a day but the maximum concentration exceeds the objective level.

Annual mean $PM_{2.5}$ levels are based on the annual mean of daily $PM_{2.5}$ concentrations.

Where data completeness requirements are not met, only number of hours per year, maximum value and number of exceedances are shown. Any exceptions are highlighted by an asterisk (*)

Collocated monitors:

Where more than one $PM_{2.5}$ monitor is operating at a single site, data are shown for the monitor currently considered the primary reporting monitor and/or the monitor reporting a complete year of data.

A common example is the collocation of new FEM instruments alongside the TEOM instruments. This is done primarily for testing purposes, to ensure satisfactory FEM performance prior to establishing the FEM instrument as the primary reporting monitor and decommissioning the older TEOM instrument.

Disclaimer:

While the information in these data summaries are believed to be accurate, the data summaries are provided as is without any warranty, and may be subject to change as changes to the underlying database occur.

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$PM_{2.5}$

Station	Monitor Type	No. Hrs.	No. Days	Annual Average	Percentiles (1h)					Maximum		Percentile (24h)	No. Exceedance Days		% Valid Hours Per Quarter			
					25th	50th	75th	98th	99th	1h	24h	98th %ile	>28 μg/m³	>25 μg/m³	Q1	Q2	Q3	Q4
Abbotsford-Airport	FEM	8661	365	5.1	2	4	6	18	24	155	20	14	0	0	100	99	100	100
Abbotsford-Mill Lake	FEM	8580	362	5.0	3	4	6	15	18	41	16	11	0	0	100	100	100	96
Agassiz	FEM	8418	357	5.0	3	4	7	15	17	32	16	12	0	0	100	92	98	100
Burnaby South	FEM	8451	358	4.7	2	4	6	14	16	114	18	11	0	0	100	91	100	100
Burnaby-Kensington Park	FEM	8615	364	4.5	2	4	6	12	14	102	13	10	0	0	98	100	100	100
Burns Lake	FEM	8414	352	6.8	3	5	8	28	34	100	28	18	0	2	100	100	100	85
Campbell River-Elk Falls	FEM	8513	323	5.5	2	4	7	27	33	126	23	16	0	0	100	100	100	100
Castlegar	FEM	8729	366	6.6	3	5	8	23	29	69	22	16	0	0	100	100	100	100
Chilliwack	FEM	8639	366	4.5	2	4	6	14	16	39	18	11	0	0	100	100	100	100
Colwood	FEM	8555	366	4.4	1	4	6	17	20	40	16	13	0	0	100	100	100	100
Courtenay	FEM	8661	366	7.7	1	4	9	45	53	94	36	32	13	16	100	100	100	100
Crofton-Georgia Hts.	FEM	8675	366	5.9	3	5	7	18	21	91	16	13	0	0	100	100	100	100
Duncan-Cairnsmore	FEM	8446	363	6.3	1	4	8	30	36	71	31	24	2	4	100	97	100	100
Duncan-Deykin Ave.	FEM	8245	359	4.3	1	3	6	21	24	43	31	17	1	2	98	100	100	95
Fort St John-Key Learning Centre	FEM	8698	366	5.6	2	4	7	22	26	114	25	16	0	0	100	100	100	100
Golden-Helipad	FEM	8693	365	7.0	3	5	8	28	35	118	23	18	0	0	100	100	99	100
Grand Forks	TEOM	8563	364	4.1	1	3	6	18	21	40	21	12	0	0	100	98	100	100
Harmac	FEM	8665	366	6.7	2	5	8	27	32	72	25	18	0	1	100	100	100	100
Hope	FEM	8597	362	4.5	2	4	6	14	18	60	20	10	0	0	98	98	100	100
Horseshoe Bay	FEM	8634	365	3.7	2	3	5	11	13	32	10	8	0	0	100	99	100	100
Houston	FEM	8768	366	8.8	3	5	9	46	57	132	37	28	8	10	100	100	100	100
Kamloops-Aberdeen	FEM	8676	364	3.3	1	2	5	12	14	44	11	9	0	0	98	100	100	100
Kamloops-Federal Bldg.	FEM	8554	361	7.9	4	7	10	22	25	75	36	16	1	2	95	100	100	100
Kelowna	FEM	8658	363	5.9	3	5	8	20	24	47	24	16	0	0	100	100	97	100
Kitimat-Haisla Village	FEM	7715	333	6.8	3	6	9	22	27	90	27	18	0	4	100	100	71	93
Kitimat-Riverlodge	FEM	8616	362	4.7	2	4	6	16	19	71	24	10	0	0	100	100	96	100
Kitimat-Whitesail	FEM	8256	359	5.5	3	5	7	17	22	67	27	13	0	2	100	100	92	100
Langdale	FEM	6131	264	.	.	.	.	.	.	178	27	.	0	1	100	86	3	100
Langley	FEM	7614	323	5.2	2	4	6	20	26	96	20	15	0	0	86	100	100	67
Lavington	FEM	8144	364	6.0	2	5	9	23	27	62	24	17	0	0	100	98	100	100
Mission	FEM	8481	360	5.1	2	4	7	18	23	77	23	13	0	0	93	100	100	100
N. Vancouver-2nd Narrows	FEM	7985	337	5.4	3	5	7	15	17	45	14	11	0	0	100	100	100	68
N. Vancouver-Mahon Park	FEM	8692	366	4.1	2	3	5	13	15	54	13	9	0	0	100	100	100	100
Nanaimo	FEM	8322	358	3.7	1	3	5	13	15	58	15	9	0	0	96	98	99	99
New Westminster	FEM	8730	365	6.1	3	5	8	17	20	67	18	13	0	0	100	100	100	100
North Delta	FEM	8719	366	4.0	2	3	5	11	13	41	13	9	0	0	100	100	100	100
Peace Valley	FEM	8212	350	5.2	2	3	6	25	32	86	54	21	4	4	86	98	100	99
Pitt Meadows	FEM	8573	363	3.9	1	3	5	15	18	49	17	12	0	0	100	99	100	100
Port Alberni	FEM	8406	357	7.1	2	5	9	32	38	85	33	23	1	3	100	100	98	92
Port Moody	FEM	8189	347	4.9	3	4	7	13	15	34	13	10	0	0	100	100	79	100
Powell River-James Thomson	TEOM	7938	343	1.6	0	1	2	8	10	49	8	5	0	0	100	100	100	75
Powell River-Wildwood	TEOM	6770	285	.	.	.	.	.	.	44	7	.	0	0	100	100	100	12
Prince George-Plaza 400	FEM	8717	365	8.4	4	6	11	29	34	144	39	21	4	4	100	99	100	100
Quesnel	FEM	8763	366	8.5	3	6	12	28	34	96	33	22	2	3	100	100	100	100
Richmond South	FEM	8420	356	4.9	2	4	6	16	19	47	17	13	0	0	97	99	98	96
Richmond-Airport	FEM	8726	366	5.0	3	4	6	16	18	38	16	12	0	0	100	100	100	100
Smithers	FEM	8773	366	7.3	2	5	9	33	41	97	32	22	1	3	100	100	100	100
Squamish	FEM	8281	358	3.7	1	3	6	13	16	28	12	10	0	0	91	100	100	100

$PM_{2.5}$ Continuation

Station	Monitor Type	No. Hrs.	No. Days	Annual Average	Percentiles (1h)					Maximum		Percentile (24h)	No. Exceedance Days		% Valid Hours Per Quarter			
					25th	50th	75th	98th	99th	1h	24h	98th %ile	>28 µg/m³	>25 µg/m³	Q1	Q2	Q3	Q4
Surrey East	FEM	8667	366	4.4	2	4	6	13	16	57	17	11	0	0	100	100	100	100
Taylor-Lone Wolf Golf Course	FEM	4884	209	.	.	.	.	.	.	74	23	.	0	0	0	89	67	72
Terrace	FEM	3371	142	.	.	.	.	.	.	57	14	.	0	0	82	0	66	7
Tsawwassen	FEM	8504	359	3.6	2	3	5	11	13	37	14	8	0	0	100	100	100	92
Valemount	FEM	8327	353	13.0	2	4	10	109	175	605	167	83	32	40	88	100	98	100
Vanderhoof	FEM	7746	330	8.5	3	6	11	34	40	97	40	26	5	10	100	90	76	95
Vernon	FEM	8684	364	6.7	3	6	9	20	23	62	22	17	0	0	100	100	100	98
Victoria-Topaz	FEM	8726	366	3.9	1	3	6	16	21	75	18	11	0	0	100	100	100	100
Whistler	FEM	7923	342	6.2	3	5	8	26	31	81	26	17	0	1	100	91	93	89
Whistler	TEOM	653	28	.	.	.	.	.	.	23	8	.	0	0	31	0	0	0
Williams Lake	FEM	8774	366	5.8	3	4	8	20	24	45	19	15	0	0	100	100	100	100

Ozone

Station	No. Hrs.	Annual Average	Percentiles (1h)					Max 1h	Daily 8h Max		% Valid Days Per Quarter				
			25th	50th	75th	98th	99th		Max	4th Highest	Q1	Q2	Q3	Q4	Q2+Q3
Abbotsford-Airport	8549	20.6	12	20	30	42	45	68	56	46	98	99	99	98	99
Abbotsford-Mill Lake	8439	18.2	9	17	27	40	43	65	53	45	92	90	98	99	94
Agassiz	8635	18.3	9	18	27	42	46	70	53	48	100	100	99	99	99
Blueberry River	4410	.	.	.	.	.	.	56	47	.	0	8	99	100	54
Burnaby Mountain	8447	27.7	22	28	34	43	46	58	51	49	98	96	96	99	96
Burnaby South	8395	17.1	9	17	25	35	37	48	43	38	100	88	97	98	92
Burnaby-Kensington Park	8584	16.6	9	16	24	37	39	50	44	39	98	97	100	98	98
Castlegar	7132	14.8	7	13	22	35	38	46	42	39	40	97	99	97	98
Chilliwack	8530	17.5	8	17	26	41	44	67	51	44	100	99	100	99	99
Colwood	8375	22.7	14	22	32	44	46	63	55	49	99	99	99	98	99
Coquitlam	8588	16.4	7	16	25	39	42	58	47	45	100	99	99	99	99
Courtenay	8326	18.9	9	19	28	42	44	56	51	45	99	99	100	96	99
Duncan	8235	17.9	7	17	28	42	45	59	51	48	100	89	99	100	94
Fort St. John-Key Learning Centre	7361	22.5	14	22	31	44	46	68	60	50	95	100	52	99	76
Hope	8605	17.6	6	17	27	44	47	66	53	51	98	99	100	99	99
Kamloops-Aberdeen	6554	23.3	17	24	30	41	42	51	45	43	99	97	98	12	97
Kamloops-Fed. Bldg.	8415	18.9	9	18	29	44	46	55	50	47	99	100	100	100	100
Kelowna	8405	21.8	12	22	31	45	47	57	51	50	98	100	100	100	100
Langley	8568	20.8	13	22	29	42	44	57	49	47	98	98	100	98	99
Maple Ridge	7968	19.8	11	20	29	43	46	72	57	50	96	100	100	66	100
Mission	8644	21.4	14	22	29	43	47	68	57	50	100	99	99	100	99
N. Vancouver-2nd Narrows	8500	15.4	7	15	22	36	39	54	41	39	99	98	93	96	96
N. Vancouver-Mahon Park	8583	17.8	9	18	26	39	41	53	45	42	99	99	96	99	97
Nanaimo	8383	20.7	15	20	27	38	40	48	43	42	100	99	99	99	99
New Westminster	8637	13.6	3	11	22	39	42	55	48	43	100	99	99	100	99
North Delta	8563	18.0	9	18	26	39	40	51	44	42	100	96	99	96	97
Pitt Meadows	8519	18.3	8	19	28	40	43	56	51	43	96	99	98	98	98
Port Moody	8618	13.5	3	12	22	38	40	61	51	42	100	99	100	99	99
Prince George-Plaza 400	8272	17.5	7	16	27	42	44	58	55	48	92	97	99	100	98
Quesnel	8325	15.2	4	12	25	44	46	58	55	49	100	96	99	99	97
Richmond South	8637	17.2	6	17	27	41	43	53	47	43	100	99	100	100	99
Richmond-Airport	8555	16.2	7	16	24	38	40	46	41	40	100	97	100	95	98
Rolla	6459	23.1	16	23	30	42	45	65	63	47	25	76	100	100	88
Smithers	8313	15.1	5	13	23	40	43	56	52	46	97	100	99	96	99
Squamish	8706	16.6	7	16	25	38	40	50	43	41	99	99	100	99	99
Surrey East	8603	20.1	12	20	28	41	43	62	54	45	98	99	100	99	99
Taylor-Lone Wolf Golf Course	6097	.	10	19	29	45	48	67	60	51	53	65	97	88	81
Terrace	7703	19.4	12	19	27	41	44	51	51	45	66	100	100	98	100
Tsawwassen	8496	23.5	16	24	32	43	45	58	50	46	100	96	97	96	96
Vancouver-Dwtn.	8545	8.7	3	7	13	29	31	40	35	33	100	97	100	97	98
Vernon	8318	17.1	6	15	27	43	45	52	50	47	95	99	98	100	98
Victoria-Topaz	8368	21.3	13	21	30	41	43	53	46	43	98	99	100	99	99
Whistler	8730	18.9	9	18	28	44	46	58	53	47	100	99	100	100	99
Williams Lake	8311	18.6	9	18	28	43	46	56	51	48	100	97	100	92	98

NO_2

Station	No. Hrs.	Annual Average	Percentiles (1h)					Max	Daily 1h Max.		% Valid Hours Per Quarter			
			25th	50th	75th	98th	99th		Annual 98th Percentile	No. Days >100 ppb	Q1	Q2	Q3	Q4
Abbotsford-Airport	8519	6.5	3	5	9	20	22	32	26	0	97	96	97	98
Abbotsford-Mill Lake	8506	7.9	4	6	11	23	26	44	33	0	97	97	95	98
Agassiz	8626	7.7	4	6	11	22	24	36	29	0	98	98	98	98
Blueberry River	4334	.	.	.	.	.	.	14	.	0	0	7	93	96
Burnaby Mountain	8505	6.6	3	6	9	20	24	41	34	0	98	96	95	98
Burnaby South	8363	12.2	7	10	16	32	35	45	40	0	98	90	96	98
Burnaby-Kensington Park	8585	11.0	6	9	14	30	34	46	40	0	97	98	98	97
Castlegar	6426	.	.	.	.	.	.	27	.	0	29	95	73	95
Chilliwack	8206	7.8	4	7	10	20	23	43	29	0	97	84	97	95
Colwood	8363	4.8	1	4	7	17	19	29	24	0	95	95	95	95
Coquitlam	8583	9.4	5	8	13	28	31	40	35	0	98	98	97	98
Courtenay	8372	4.0	2	3	5	16	18	37	28	0	96	95	95	95
Duncan	8299	4.5	2	4	6	15	17	23	20	0	95	94	94	95
Fort St John	7340	.	.	.	.	.	.	54	.	0	94	95	95	51
Hope	8632	5.8	3	5	8	17	18	27	23	0	98	98	98	98
Kamloops-Aberdeen	8395	2.4	1	1	3	12	15	30	19	0	96	96	96	95
Kamloops-Fed. Bldg.	8391	10.1	5	8	14	28	32	42	36	0	96	95	96	96
Kelowna	8255	6.8	3	5	10	23	25	41	30	0	88	96	96	96
Langdale	8385	5.4	3	5	7	14	16	33	23	0	96	96	95	95
Langley	8568	5.5	3	4	7	18	20	33	24	0	97	98	98	98
Maple Ridge	8548	7.4	3	6	10	24	28	39	33	0	97	99	98	95
Mission	8620	6.4	3	5	8	22	24	39	30	0	98	98	98	98
N. Vancouver-2nd Narrows	8589	12.0	6	10	16	32	35	51	45	0	98	98	98	97
N. Vancouver-Mahon Park	8593	10.9	5	9	15	30	33	45	38	0	98	98	98	98
Nanaimo	8374	6.3	3	5	9	19	22	35	27	0	96	95	95	95
New Westminster	8636	15.2	9	14	21	34	36	50	41	0	100	99	99	100
North Delta	8583	12.4	6	10	17	34	38	56	42	0	98	97	98	98
Pitt Meadows	8445	7.3	3	6	10	26	29	39	34	0	93	97	97	97
Port Moody	8630	12.0	7	11	16	29	32	46	38	0	98	98	98	98
Powell River	8245	2.0	1	1	2	8	10	27	14	0	92	93	95	96
Prince George	7622	8.9	3	6	13	31	34	60	41	0	96	94	79	79
Quesnel	8289	7.6	3	5	11	26	28	39	34	0	96	91	95	96
Richmond South	8620	11.7	4	10	18	33	35	48	39	0	98	98	98	98
Richmond-Airport	8591	14.3	7	12	21	37	40	54	45	0	98	98	98	97
Rolla	8087	2.1	1	1	3	11	14	27	20	0	96	81	96	96
Smithers	8380	5.0	1	3	7	19	20	29	23	0	95	96	95	96
Squamish	8654	5.9	3	5	8	18	20	40	26	0	97	99	99	98
Surrey East	8583	8.2	4	6	11	25	28	41	34	0	97	98	98	98
Taylor-Lone Wolf Golf Course	6874	.	.	.	.	.	.	40	.	0	56	68	95	94
Terrace	8355	2.2	1	1	3	11	14	28	21	0	95	96	95	95
Tsawwassen	8525	6.3	2	4	8	25	28	54	35	0	94	98	98	98
Vancouver-Dwtn.	8586	18.5	12	18	24	36	38	50	44	0	98	98	98	96
Vernon	6807	.	.	.	.	.	.	49	.	0	88	31	95	96
Victoria-Topaz	8288	8.5	4	7	12	25	29	44	37	0	94	95	95	93
Whistler	8667	3.9	2	3	5	15	16	29	21	0	98	99	99	99
Williams Lake	8117	5.7	2	4	8	21	23	34	29	0	96	87	91	96

SO_2

Station	No. Hrs.	Annual Average	Percentiles (1h)						Percentiles (Daily 1h Max)				No. Exceedances		% Valid Days Per Quarter			
			25th	50th	75th	98th	99th	Max	97th %ile	97.5%ile	98%ile	99%ile	No. Hrs>75 ppb	No. Days>75 ppb	Q1	Q2	Q3	Q4
Abbotsford-Airport	8407	0.2	0	0	0	1	2	8	3	4	4	4	0	0	97	100	92	100
Abbotsford-Mill Lake	8585	0.2	0	0	0	1	2	6	4	4	4	5	0	0	99	99	100	100
Bessborough	8194	0.6	0	1	1	2	2	11	3	3	4	5	0	0	90	97	98	98
Blueberry River	3657	.	.	.	.	.	.	17	.	.	.	.	0	0	0	8	99	64
Burnaby North	8636	1.0	0	1	1	6	7	45	11	11	12	21	0	0	100	99	100	100
Burnaby South	8386	0.3	0	0	0	2	2	5	3	3	3	4	0	0	99	90	99	99
Burnaby-Capitol Hill	8614	0.5	0	0	0	4	7	52	25	25	27	32	0	0	100	100	100	100
Burnaby-Kensington Park	8573	0.3	0	0	0	2	2	8	4	5	5	6	0	0	98	100	100	96
Castlegar	8402	2.2	0	0	1	21	27	94	37	37	40	52	3	3	100	99	100	100
Chilliwack	8495	0.1	0	0	0	1	1	81	2	2	2	2	1	1	100	100	97	100
Colwood	8270	0.6	0	1	1	2	2	5	3	3	3	3	0	0	100	99	96	96
Crofton-Georgia Hts.	7799	2.2	1	1	2	16	22	182	44	46	52	71	3	3	78	100	93	99
Farmington	2689	.	.	.	.	.	.	4	.	.	.	.	0	0	99	29	0	0
Fort St John-Key Learning Centre	6724	.	.	.	.	.	.	6	.	.	.	.	0	0	98	22	100	100
Kamloops-Aberdeen	1113	.	.	.	.	.	.	2	.	.	.	.	0	0	53	0	0	0
Kamloops-Federal Bldg.	8414	0.6	0	1	1	2	3	8	6	6	6	7	0	0	100	100	100	100
Kelowna	8097	0.3	0	0	0	1	1	3	2	2	2	2	0	0	96	100	100	87
Kitimat-Haisla Village	8312	0.4	0	0	0	2	4	37	8	9	11	20	0	0	99	100	97	100
Kitimat-Riverlodge	8375	0.5	0	0	0	4	6	32	13	14	14	22	0	0	100	100	100	100
Kitimat-Whitesail	8366	0.5	0	0	0	3	5	37	11	12	12	15	0	0	100	100	98	100
Langdale	7884	0.7	0	1	1	3	4	16	6	6	7	8	0	0	100	87	88	100
Langley Central	8572	0.1	0	0	0	1	1	10	3	3	3	4	0	0	99	100	100	100
N. Vancouver-2nd Narrows	8567	0.4	0	0	1	2	3	16	4	5	5	6	0	0	98	99	100	98
N. Vancouver-Mahon Park	8482	0.3	0	0	0	1	2	22	3	3	3	5	0	0	99	100	100	93
Pitt Meadows	8554	0.3	0	0	0	1	2	5	3	3	3	3	0	0	96	100	100	99
Port Alberni	8422	0.6	0	1	1	2	3	9	5	5	6	7	0	0	100	100	100	100
Port Moody	8545	0.3	0	0	0	3	3	65	5	5	5	6	0	0	96	100	100	100
Prince George-Plaza 400	8205	1.9	1	1	2	12	16	47	28	30	31	43	0	0	91	96	100	98
Quesnel	8312	0.2	0	0	0	2	3	16	8	8	9	12	0	0	100	97	100	100
Richmond South	8528	0.3	0	0	0	1	2	7	3	3	3	4	0	0	95	99	100	100
Richmond-Airport	8597	0.2	0	0	0	1	2	3	3	3	3	3	0	0	100	99	100	100
Rolla	8068	0.3	0	0	0	1	2	14	4	4	4	4	0	0	99	79	100	100
Squamish	8698	0.9	1	1	1	2	2	5	3	3	3	3	0	0	100	100	100	100
Taylor-Lone Wolf Golf Course	7564	0.3	0	0	0	3	5	25	9	11	12	14	0	0	69	89	98	98
Taylor-South Hill	8327	0.3	0	0	0	2	3	47	8	8	9	11	0	0	100	99	99	99
Taylor-Townsite	8362	0.7	0	0	1	5	8	31	17	17	19	27	0	0	100	100	97	99
Terrace	8315	0.5	0	0	1	3	3	6	4	4	4	5	0	0	98	97	100	99
Trail-Birchbank	3315	.	.	.	.	.	.	151	116	117	121	128	34	17	0	0	53	99
Trail-Butler Park	8306	11.7	1	3	10	93	121	287	207	213	232	245	245	119	100	100	95	100
Trail-Columbia Gardens Airport	3423	.	.	.	.	.	.	104	77	83	90	96	7	6	0	0	61	100
Trail-Warfield	3313	.	.	.	.	.	.	252	186	191	192	211	69	25	0	0	54	99
Tsawwassen	8610	0.4	0	0	1	1	1	8	3	3	3	4	0	0	100	100	100	100
Vancouver-Dwtn.	5554	.	.	.	.	.	.	6	.	.	.	.	0	0	59	85	100	12
Victoria-James Bay	8719	0.1	0	0	0	1	1	16	2	2	2	3	0	0	99	98	100	100
Victoria-Topaz	8351	0.8	1	1	1	2	3	7	4	4	4	5	0	0	99	100	100	98
Williams Lake	1387	.	.	.	.	.	.	2	.	.	.	.	0	0	0	0	0	65

Note: Trail Columbia Gdns, Birchbank and Warfield not validated until beginning Aug. 1, 2016.