Clean Air Plan Backgrounder

Metro Vancouver’s 10-year Action Plan for Air Quality and Greenhouse Gases

September 2019
Metro Vancouver is a federation of 21 municipalities, one Electoral Area and one Treaty First Nation that collaboratively plans for and delivers regional-scale services. Its core services are drinking water, wastewater treatment and solid waste management. Metro Vancouver also regulates air quality, plans for urban growth, manages a regional parks system and provides affordable housing. The regional district is governed by a Board of Directors of elected officials from each local authority.

Member jurisdictions of Metro Vancouver include:

- Village of Anmore
- Village of Belcarra
- Bowen Island Municipality
- City of Burnaby
- City of Coquitlam
- City of Delta
- Electoral Area A
- City of Langley
- Township of Langley
- Village of Lions Bay
- City of Maple Ridge
- City of New Westminster
- City of North Vancouver
- District of North Vancouver
- City of Pitt Meadows
- City of Port Coquitlam
- City of Port Moody
- City of Richmond
- City of Surrey
- Tsawwassen First Nation
- City of Vancouver
- District of West Vancouver
- City of White Rock

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Introduction

Metro Vancouver is responsible for managing and regulating air contaminants in the Metro Vancouver region. As the next in its series of Air Quality Management Plans, Metro Vancouver is now developing the Clean Air Plan to further reduce regional air contaminant emissions, including greenhouse gases, over the next 10 years. The Clean Air Plan is an action plan that directly supports the vision of Climate 2050, Metro Vancouver’s long-term climate strategy, and protects public health and the environment.

Metro Vancouver, together with its member jurisdictions, has taken action on air quality and climate change for decades. As a result, residents in our region generally experience good air quality, and there have been reductions in regional greenhouse gas emissions over the past 15 to 20 years. The Clean Air Plan seeks to accelerate actions on regional air quality and greenhouse gas emissions to further address our local contribution to global climate change, and protect public health and the environment.
Purpose

This Clean Air Plan Backgrounder outlines a framework for the Clean Air Plan and describes seven prioritized areas for action to be included in the Plan. It also identifies a proposed vision and targets for air quality and greenhouse gases in this region. The backgrounder is intended for the following audiences:

• the public;
• member jurisdictions;
• local First Nations, and BC and federal governments and agencies;
• other regional authorities (e.g., TransLink, Fraser Valley Regional District);
• health authorities;
• energy utilities (e.g., BC Hydro, FortisBC);
• industry and business associations;
• professional organizations and academic institutions;
• youth;
• community, environmental and other non-profit groups; and
• other interested parties.

In addition to this backgrounder, Metro Vancouver is developing discussion papers on the seven prioritized issue areas for action to support engagement on the Clean Air Plan.

A note on format: bold words are key concepts and are generally defined in the Glossary at the back of the Backgrounder.
Defining the Problem

Air Contaminants

The air we breathe is mostly made up of gases, with some suspended liquids and solids. By weight, air is 78% nitrogen, 21% oxygen, 1% argon, along with small amounts of other compounds, including air contaminants. While air contaminants account for only a tiny fraction of the air we breathe, their impacts can be significant.

Air contaminants can have a variety of impacts (see Glossary for complete list). Metro Vancouver’s air quality and greenhouse gas management programs focus on regional air contaminants with direct public health impacts and air contaminants with impacts on climate change. Reducing the levels of these air contaminants can have other benefits, including improving visual air quality and reduced impacts on the environment, property and businesses.

The air contaminants with the most impact in Metro Vancouver are shown below.

- **Common air contaminants**: These air contaminants can harm public health and reduce residents’ quality of life and life expectancy by causing heart and lung diseases, cancer, asthma, and other impacts. Some air contaminants have odorous characteristics. Common air contaminants include fine and coarse particulate matter, diesel particulate matter, ground-level ozone, nitrogen dioxide, sulphur dioxide, and volatile organic compounds.

- **Greenhouse gases**: These air contaminants trap heat and are the cause of climate change. Greenhouse gases include carbon dioxide and nitrous oxide, as well as short-lived climate forcers such as methane, halocarbons, black carbon and ozone.

Air Quality Trends, Impacts and Challenges

Air quality monitoring over the last decade indicates that most common air contaminant levels have been improving, even while the region’s population has grown. These improvements are due in part to policies, programs and regulations that have led businesses and residents to adopt emission control technologies and change practices. But more effort is still needed.

Every five years, Metro Vancouver develops an emissions inventory, which describes the types and amounts of common air contaminants and greenhouse gases emitted in the region, and also forecasts how emissions could change in the future. According to the most recent inventory, completed in 2017, without additional action:

- fine particulate matter emissions are expected to remain fairly constant through 2035; and
- emissions of nitrogen oxides and volatile organic compounds (which lead to the formation of ground-level ozone) are projected to start increasing after 2030.

Health Canada estimates that 1,600 British Columbians die prematurely every year due to exposure to fine particulate matter, ground-level ozone and nitrogen dioxide. These same contaminants cause 170,000 asthma symptom days in Metro Vancouver every year, as well as other health effects.

Monitored levels of fine particulate matter and ground-level ozone in the region exceeded ambient air quality objectives during several periods in recent years, in part due to air contaminants transported from outside this region, for example from wildfires. Health researchers from Canada and around the world have indicated there are continued benefits from reducing ambient concentrations of common contaminants.
air contaminants, even when those concentrations are already low. There are no known safe levels for some common air contaminants, including fine particulate matter, ground-level ozone and nitrogen dioxide. **Additional emission reduction actions are needed to continue protecting human health and the environment.** (See the Glossary for more information on these air contaminants.)

Emissions, Ambient Air Quality and Health Exposure

- Emissions are the air contaminants we release into the air; they are most concentrated near the emission source and are diluted over time and distance.
- Ambient air quality is the concentration of air contaminants in the outdoor air, measured in parts per billion or micrograms per cubic metre.
- Exposure is the air contaminants you breathe where you live, study, play and work.

**Climate Change and Air Quality**

Climate change projections for this region for 2050 include longer, hotter and drier summers, warmer and wetter fall and winter seasons with decreased snowpack, and more extreme weather events. Wildfires are expected to become more intense and more frequent, impacting this region with harmful smoke.

Climate change is directly associated with greenhouse gas emissions, primarily carbon dioxide. While emissions are global, we all have a shared responsibility to take local action. The major sources of greenhouse gas emissions in this region are transportation, buildings and industry, with smaller contributions from waste and agriculture.

To align with global emissions targets and Climate 2050, Metro Vancouver’s long-term climate strategy, we need to decrease regional emissions by nearly 100% in the next 30 years. However, the emissions inventory for the region suggests that, with population growth and without additional actions, regional greenhouse gas emissions are not expected to decrease significantly in the next 15 years.

We need to accelerate our regional climate actions to avoid dangerous levels of climate change. The Clean Air Plan is the action plan that will directly address greenhouse gas emissions from sources in this region, supporting the vision of Climate 2050. More information on climate change and greenhouse gases is available on the Climate 2050 website⁴.

⁴ Climate 2050 website [www.metrovancouver.org/climate2050](http://www.metrovancouver.org/climate2050)
Roles and Responsibilities

Metro Vancouver’s Board Strategic Plan

Metro Vancouver’s Board Strategic Plan 2019 to 2022 identifies five themes to guide the development of Metro Vancouver’s long-term plans, including environmental sustainability, system stewardship, and regulatory and legislative environment. The strategic directions for air quality and climate change for 2019 to 2022 are:

1. guide climate change policy and action for the Metro Vancouver region for the next 30 years with Metro Vancouver’s Climate 2050 strategy; and

2. improve air quality by mitigating threats to public health and the environment.

Air Quality and Climate Change

Metro Vancouver is responsible for managing and regulating air contaminants in the region under authority delegated by the BC Government in the Environmental Management Act. Metro Vancouver uses this authority to:

• develop plans and strategies to guide management of air contaminants;

• establish ambient air quality objectives to protect public health and the environment;

• measure and report on ambient air quality, air contaminant emissions and visual air quality using one of the most comprehensive air quality monitoring networks in Canada;

• issue air quality permits to control emissions from industrial facilities;

• adopt and enforce air emission regulations to control air contaminants from key emission sources; and

• develop and operate outreach and incentive programs to reduce regional emissions of common air contaminants and greenhouse gases.

Metro Vancouver has other roles in the region that impact air contaminant emissions, outlined below.

• Metro Vancouver 2040: Shaping our Future, the regional growth strategy, includes a goal to develop compact, complete communities that promote walking, cycling, transit, carpooling, and reduced trip distances, reducing emissions from transportation and buildings.

• The Regional Parks system protects and advocates for enhanced conservation of forests and green spaces, which absorb and store (i.e., sequester) carbon dioxide.

• Metro Vancouver’s utilities (Water Services, Solid Waste and Liquid Waste), Regional Parks and Metro Vancouver Housing are working to reduce emissions from operations.

Air quality and greenhouse gas management requires close coordination with other levels of government, utilities, and others. The roles of key partners are described below.

• The Federal Government regulates new vehicle performance and fuels as well as emissions from marine vessels, rail locomotives, non-road vehicles and engines, home heating appliances, some industrial sources and toxic substances. The federal government coordinates the national Air Quality Management System to improve air quality in Canada, and regulates emissions for federal undertakings, including rail corridors, shipping lanes, the Vancouver Fraser Port Authority, and the Vancouver International Airport Authority.

• The BC Government manages air quality in the province for areas outside of Metro Vancouver, including adjacent regional districts. The BC Government sets emission standards for vehicles, fuels and other emission sources. Provincial legislation requires regional districts and municipalities in BC to set community greenhouse gas emission targets and identify reduction actions.

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• **First Nations** in the Metro Vancouver region provide services to their communities and a number of First Nations in the region have adopted sustainability and/or land use plans. The Tsawwassen First Nation is a Metro Vancouver member jurisdiction and has similar authority and powers as other member jurisdictions with respect to climate change.

• **Municipalities** are responsible for land-use policy and enforcing the BC Building Code. Many municipalities have adopted climate action and environmental plans and are taking actions to reduce their emissions. All of Metro Vancouver’s municipalities have shown leadership by signing the BC Climate Action Charter.

• **TransLink** plans, manages and finances public transit in this region, and shares responsibility for the major road network and regional cycling network with municipalities and the BC Government. The federal and BC governments also provide funding for transit and transportation network projects.

• The **Fraser Valley Regional District** shares the Canadian Lower Fraser Valley airshed with Metro Vancouver. The District has air quality planning authority and is currently developing an updated air quality management plan.

• **Health authorities** provide information on the health impacts of air contaminants to support air quality management actions.

• **Energy utilities** such as BC Hydro and FortisBC supply energy for residents and businesses, as well as provide incentives to owners to reduce emissions and energy consumption.

Clean Air Plan

The Clean Air Plan will be Metro Vancouver’s fourth air quality and greenhouse gas management plan. It will build on existing Metro Vancouver air quality and greenhouse gas management programs and policies, as well as the Board Strategic Plan and initiatives by member jurisdictions, partner agencies and local First Nations (e.g., the provincial CleanBC plan and member jurisdictions’ sustainability, environment, climate and energy plans).

The Clean Air Plan will focus on actions that Metro Vancouver can implement under its delegated authority, and will also identify actions for implementation by others. The Plan will identify actions to reduce air contaminant emissions and impacts, including greenhouse gases, in our region over the next 10 years. Actions include incentives, educational outreach campaigns and regulations. Where possible, the Plan will target common air contaminants and greenhouse gases together because many emission sources in this region emit both types of air contaminants (e.g., gasoline engines, natural gas furnaces, industrial manufacturing processes).

The Clean Air Plan will be organized around seven issue areas.

1. Buildings
2. Transportation
3. Industry and Commerce
4. Waste
5. Agriculture
6. Nature and Ecosystems
7. Measurement, Monitoring and Regulation

The first five issue areas focus on the largest regional sources of air contaminant emissions. The sixth issue area relates to the impacts of nature and ecosystems on air contaminants, and the final issue area describes the tools and approaches that Metro Vancouver and our partners use to reduce emissions and manage air quality in our region.

Each issue area will include:

- **long-term goal(s)**: identify the desired end state for the issue area, in support of the regional vision, with expected achievement in 2050 and beyond;
- **2030 targets**: as milestones to measure progress toward achieving the long-term goal(s); and
- **strategies and actions**: to achieve the targets.

Climate 2050

Climate 2050 is an overarching long-term strategy that will guide our region’s policies and collective actions to transition to a carbon neutral and resilient region over the next 30 years. Metro Vancouver is implementing Climate 2050 through ten issue area Roadmaps, which will describe how to reduce greenhouse gas emissions and adapt to climate change impacts. Climate 2050 includes the following greenhouse gas targets for this region.

- Become a carbon neutral region by 2050
- Reduce regional greenhouse gas emissions by 45% from 2010 levels by 2030

Metro Vancouver and its regional partners are developing the first iterations of the Climate 2050 Roadmaps in 2019 and 2020. Implementation of the Roadmaps will be driven by Metro Vancouver’s management plans and other policies, including the Clean Air Plan.
Links between *Clean Air Plan* and *Climate 2050*

Actions in the *Clean Air Plan* will directly support the *Climate 2050* greenhouse gas targets by addressing greenhouse gas emissions from key regional sources. *Climate 2050* broadens the discussion to address how the region will adapt to a changing climate, and also examines additional issue areas (e.g. Infrastructure, Land-use and Growth Management, Human Health and Well-being).

*Climate 2050* will set the direction for addressing climate change in the region over the next 30 years. Any greenhouse gas targets adopted as part of *Climate 2050* will be reflected in the *Clean Air Plan*. The *Clean Air Plan* will identify the suite of actions needed to achieve 2030 greenhouse gas reduction targets, while also including 2030 air quality targets and actions.

The first six issue areas in the *Clean Air Plan* (see previous page) match six of the *Climate 2050* issue areas since many of the sources in these issue areas generate both common air contaminants and greenhouse gases (e.g., gasoline engines, natural gas furnaces, industrial manufacturing processes).

The content of *Climate 2050* and the *Clean Air Plan* is summarized in the following table.

<table>
<thead>
<tr>
<th>TOPIC</th>
<th>CLEAN AIR PLAN</th>
<th>CLIMATE 2050 ROADMAPS</th>
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<tbody>
<tr>
<td>Greenhouse gases</td>
<td>Included - focuses on near-term actions under Metro Vancouver’s delegated authority</td>
<td>Included - considers actions to achieve 2050 carbon neutral region target</td>
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<tr>
<td>Common air contaminants</td>
<td>Not included</td>
<td>Not included</td>
</tr>
<tr>
<td>Climate change adaptation</td>
<td>Not included</td>
<td>Included - considers actions to achieve a resilient region</td>
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Discussion Papers

Metro Vancouver is developing a series of discussion papers for the issue areas in the *Clean Air Plan* (e.g., transportation, industry and commerce, buildings). The discussion papers are an engagement tool, and will support discussions with the public, stakeholders and other levels of government, including First Nations.

Each issue area discussion paper will include content on:

1. common air contaminants and related air quality issues;
2. greenhouse gas emission reductions; and
3. climate change adaptation.

Including climate change adaptation in the discussion papers will streamline the engagement processes for the *Clean Air Plan* and the *Climate 2050 Roadmaps*.

Action Evaluation Framework

To support development of the *Clean Air Plan*, Metro Vancouver is creating an evaluation framework to rank the actions included in the Plan. Actions will be ranked based on expected emissions reductions, impacts on visual air quality and equity, corporate leadership, and other criteria based on the Plan’s proposed guiding principles.

More detailed impact analyses for some actions included in the final *Clean Air Plan*, such as new or amended air emission regulations with a significant scope, would be conducted following adoption of the Plan.
Proposed Vision and Regional Targets

In alignment with Metro Vancouver’s Board Strategic Plan, and the carbon neutral vision in Climate 2050, the proposed vision for the Clean Air Plan is:

Metro Vancouver has healthy, clean and clear air, and is a carbon neutral region.

Residents, businesses and government will all need to work together to achieve this vision, so that we have a thriving region with healthy communities and a clean environment.

The Clean Air Plan will identify actions for the next 10 years that advance toward this vision. To track progress, Metro Vancouver proposes the following as 2030 regional targets:

1. reduce regional greenhouse gas emissions by 45% from 2010 levels;

2. ambient air quality in the region meets or is better than ambient air quality objectives and standards set by Metro Vancouver, and the BC and federal governments; and

3. increase the amount of time that visual air quality is classified as excellent.

The greenhouse gas target matches the 2030 greenhouse gas target adopted by the Metro Vancouver Board in July 2019 as part of the Climate 2050 process. (See the Glossary for more information on ambient air quality objectives and visual air quality.)
Proposed Guiding Principles

The Clean Air Plan will identify actions for Metro Vancouver and its partners that can reduce the emissions and impacts of common air contaminants and greenhouse gases in this region. Decisions about which actions to include in the Clean Air Plan will be informed by a set of guiding principles which represent our regional values.

Building on the guiding principles for Climate 2050, the following guiding principles are proposed for the Clean Air Plan.

1. **Ambitious** – Demonstrate global and local leadership by ambitiously tackling our local climate and air quality challenges.

2. **Dynamic** – Evolve our approach to respond to new information, support innovation, and take advantage of emerging opportunities, with an objective of continuous improvement.

3. **Evidence-based** – Inform decision-making with the most current scientific information, traditional knowledge, and local understanding of air contaminant emissions and impacts.

4. **Relevant** – Design actions to respond to Metro Vancouver’s unique role, opportunities and challenges and deliver regional benefits.

5. **Comprehensive** – Undertake or support emission and impact reduction actions across sectors and communities that prioritize co-benefits, consider trade-offs and avoid negative consequences to the degree possible.

6. **Integrated** – Ensure actions are integrated with, and enhance, other municipal and regional policy priorities and are coordinated with local First Nations, provincial and federal initiatives.

7. **Fair** – Seek solutions that equitably address the risks from climate change and air contaminants, fairly share the costs and benefits of action, and support a livable, thriving, and affordable region, including responsibility to future generations.

8. **Actionable** – Propose actions that can realistically be implemented given Metro Vancouver’s mandate, finances and capacities; if necessary consider changes to mandate.

9. **Inclusive & Collaborative** – Involve Metro Vancouver’s member jurisdictions, local First Nations, strategic partners, residents, and businesses in the planning and implementation of the Clean Air Plan.

10. **Transparent & Verifiable** – Follow an open decision-making process, and set goals and targets that can be measured, reported, verified, and evaluated.

11. **Preventative** – Encourage the use of processes, practices, materials and energy in ways that avoid or minimize the creation of air contaminants at the source, rather than remedial efforts after air contaminants have been released.

**Trade-offs and Co-benefits**

Assessing co-benefits and trade-offs are a key consideration when developing air quality and climate actions. There is a significant overlap between the sources of greenhouse gases and common air contaminants, so actions that target emissions reductions to protect public health can often (but not always) reduce greenhouse gases, and vice versa. For example, expanded use of electric vehicles will reduce greenhouse gases. As a co-benefit, it will also reduce fine particulate matter and nitrogen oxides.

In some cases, deciding on the most appropriate action will require trade-offs and balancing the health and climate benefits of reducing emissions against costs and other impacts. Approaches for reducing one air contaminant can increase the emissions of another. For example, encouraging the use of biomass or wood (over other fuels) as a renewable fuel source to reduce greenhouse gas emissions could increase emissions of fine particulate matter and nitrogen oxides.
Developing a Fair and Equitable Plan

Climate change and degraded air quality impact some neighbourhoods, households and individuals more than others. Also, some households are better able to prepare for and protect themselves from climate impacts.

A priority of the Clean Air Plan is to incorporate the voices and needs of a range of views and experiences into program and policy design to ensure that fairness and equity are reflected in the Clean Air Plan’s guiding principles, goals, targets, strategies and actions. Equity can include a range of parameters: intergenerational, gender, heritage, disability, income, location, access to information and more. Policies and programs that reduce emissions should support an equitable distribution of benefits and costs, such as increased opportunities in a low emissions economy, affordable housing and more diverse transportation options.

We are seeking this feedback from diverse communities to help identify the needs, priorities, actions and opportunities for change that will lead to more fair and equitable air quality and climate policies. Diverse feedback will enhance the effectiveness of the Clean Air Plan to reduce emissions and improve the livelihoods of all communities.
Feedback and Engagement Process

Help shape the Clean Air Plan

Metro Vancouver invites feedback from diverse viewpoints to help shape the Clean Air Plan, and will carefully consider all input. Feedback is welcome by email at CleanAirPlan@metrovancouver.org or by telephone at 604-432-6200.

Participation Opportunities

Metro Vancouver will provide a variety of engagement opportunities to hear input on this Backgrounder and the associated discussion papers. The public, stakeholders and other levels of government, including First Nations, can participate through the following:

• online public survey;
• open comments to a dedicated email account;
• public dialogue or forum;
• public webinars; and
• direct feedback to Metro Vancouver staff.

Details about events will be posted on the Clean Air Plan website.

Feedback on any part of the discussion materials is welcome anytime throughout the engagement. Initial events will focus on the proposed regional vision and targets, and initial identification of potential actions. The next area of focus will be specific to each issue area including potential emissions pathways.

To ensure your comments are considered please provide feedback by March 31, 2020. Comments and suggestions will be compiled into a summary report for consideration by the Metro Vancouver Board, and will be made publicly available in 2020.

With revisions from the initial engagement, the discussion materials will form the basis of the draft Clean Air Plan. The draft Plan will be made available for comment before it is finalized.

Metro Vancouver staff will treat personal information with confidentiality; please note that comments you submit may be provided to a third party if a freedom of information (FOI) request is made under the Freedom of Information and Protection of Privacy Act. If you have any questions or comments regarding the engagement process, please call 604-432-6200.

Thank you for taking the time to provide your valuable feedback. For more information, visit www.metrovancouver.org and search “Clean Air Plan”, or call 604-432-6200.
Glossary

**Air contaminant** is any substance that is emitted into the air that does or could a) harm public health (including material physical discomfort) and property, b) damage the environment, including the climate, c) impede normal business operations, or d) impair visual air quality.

**Ambient air quality objectives and standards** are health-based targets which define the acceptable outdoor concentration of key air contaminants. Metro Vancouver and the BC and federal governments adopt objectives and standards that become more stringent over time, to drive continuous improvement in air quality.

**Carbon neutral region** is a region that has achieved the deepest greenhouse gas emissions reductions possible across all economic sectors, and removes or captures sufficient carbon dioxide to balance any remaining regional greenhouse gas emissions.

**Climate change adaptation** means anticipating, planning for and responding to the adverse effects of climate change and taking appropriate action to prevent or minimise the damage it can cause, or taking advantage of opportunities that may arise. It has been shown that well planned, early adaptation action saves money and lives later.

**Common air contaminants** are air pollutants that can harm public health and reduce residents’ quality of life and life expectancy by causing heart and lung diseases, cancer, asthma, and other impacts. Some air contaminants have odorous characteristics. Common air contaminants include fine and coarse particulate matter, diesel particulate matter, ground-level ozone, nitrogen dioxide, sulphur dioxide and volatile organic compounds.

**Fine particulate matter** ($PM_{2.5}$) is made up of tiny solid or liquid particles that float in the air and can penetrate deep into the lungs and even the bloodstream. Particulate matter can damage health by aggravating existing lung and heart diseases, increasing the risk of cancer and reducing life expectancy.

**Diesel particulate matter** is a form of particulate matter from diesel engines that is classified as carcinogenic.

**Greenhouse gases** are air pollutants that trap heat and are the cause of climate change. Greenhouse gases include carbon dioxide and nitrous oxide, as well as short-lived climate forcers such as methane, halocarbons, black carbon and ozone. Limiting or preventing greenhouse gas emissions and removing these gases from the atmosphere is critical to avoiding catastrophic climate change (sometimes referred to as climate change mitigation).

**Ground-level ozone** ($O_3$) can have harmful impacts on everyone, especially children, seniors, and people with lung and heart conditions. It is primarily formed when nitrogen oxides and volatile organic compounds react in the air on hot and sunny days.

**Nitrogen dioxide** ($NO_2$) can damage health by aggravating existing lung diseases like asthma and bronchitis, and reducing immunity to lung infections. It is formed during high-temperature fuel combustion, and can contribute to the formation of ground-level ozone and fine particulate matter.

**Sulphur dioxide** ($SO_2$) is emitted during the combustion of sulphur-containing fuels. Exposure to high levels of sulphur dioxide can damage health by aggravating asthma and increasing respiratory symptoms. It can also react with other substances in the air to form fine particulate matter.

**Visual air quality** is how clear the air looks to the average observer. Metro Vancouver and its partners measure visual air quality on a scale from “very poor” to “excellent” at five sites in the Lower Fraser Valley.

**Volatile organic compounds** (VOC) are compounds that easily become vapours or gases; they are emitted during fuel combustion and from many consumer products. They have direct and indirect impacts on human health and contribute to the formation of ground-level ozone.